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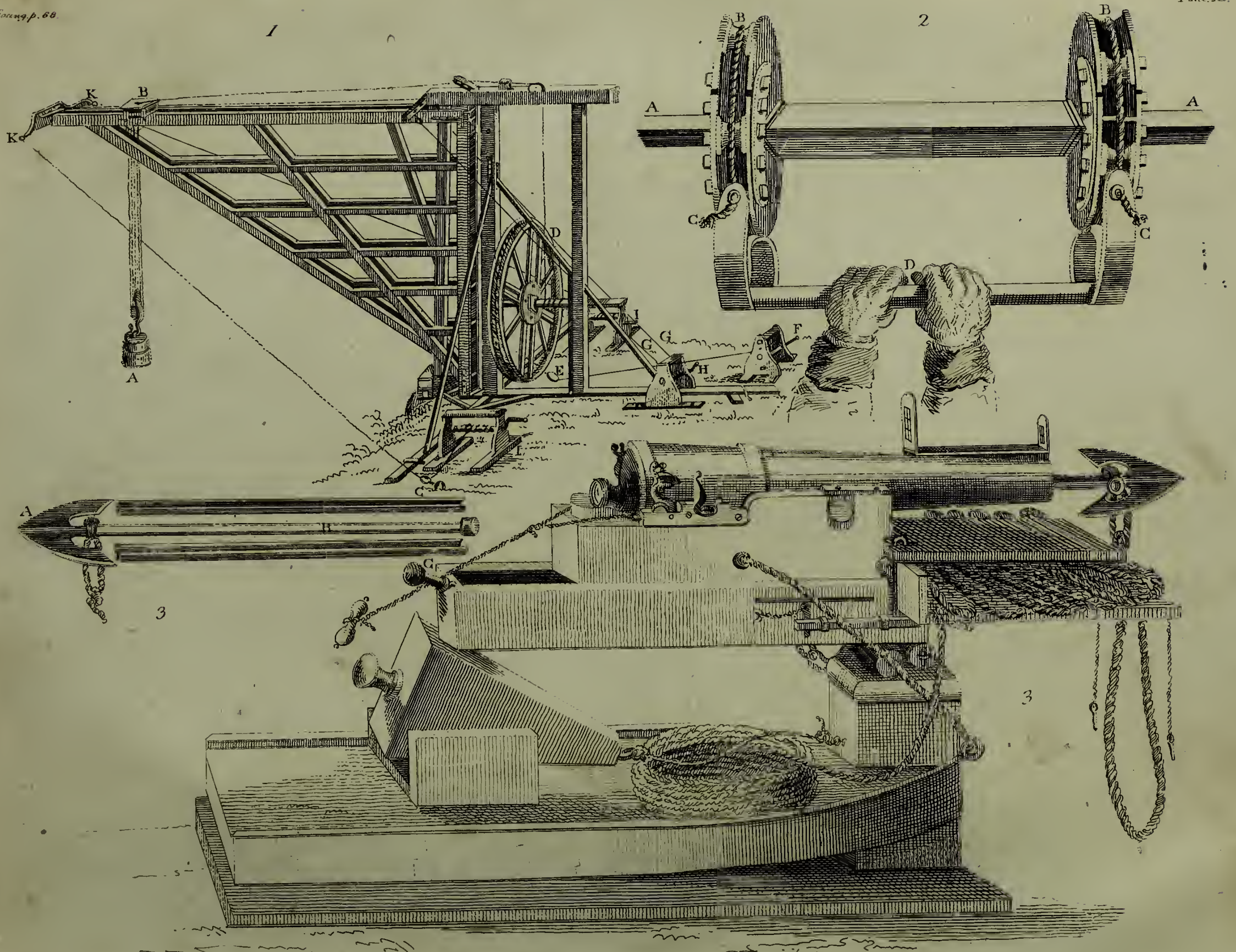
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L. A. Rose

MEMOIRS
OF
SCIENCE AND THE ARTS;
OR
A GENERAL ABRIDGEMENT OF THE TRANSACTIONS
PUBLISHED BY THE
PRINCIPAL LEARNED AND ŒCONOMICAL SOCIETIES
ESTABLISHED IN THE
DIFFERENT PARTS OF THE WORLD:
CONSISTING OF
A number of curious and intereſting Articles in Agriculture, Botany, Hiſtory,
Antiquities, Biography, Chemiſtry, Mechanics, &c. &c.
The Whole ſelected with Judgment from the
TRANSACTIONS
OF THE
Royal and Antiquarian Societies of London and Edinburgh; the Linnæan Society; Society for the Encouragement of Arts; the Bath Agricultural Society; Royal Iriſh Academy; Philoſophical Society at Mancheſter; American Philoſophical Society; the African Aſſociation; Society of Natural Hiſtory at Paris; Royal Society of Gottingen; Society of Natural Philoſophy and Academy of Sciences and Belles Lettres at Berlin; the Aſiatic Tranſactions, &c.

BY A MEMBER OF THE ROYAL COLLEGE OF PHYSICIANS,
OF LONDON.

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PREFACE.

NO circumſtance has more diſtinguiſhed the modern attempts for the improvement of Arts and Sciences, from thoſe of antiquity, than the inſtitution of ſocieties, for the purpoſe of purſuing enquiries in common, or of collecting the labours of individuals, and offering them conjunctly to the public. To Italy, the country in which literature firſt revived from the torpidity of the dark ages, was owing the firſt riſe of theſe ſocieties, which in a ſhort time became exceedingly numerous in all its principal towns. Moſt of theſe, indeed, employed themſelves in philoſophical purſuits, or in the light productions of elegant literature; yet the Academy of *Lyncæi*, inſtituted at Rome in 1603, had ſcience for its object, and has ſerved as a model for later ſocieties of the kind; and the Florentine Academy *del Cimento*, as its name imports, brought phyſical opinions to the teſt of experiment. The ſame plan was followed with vigour by that aſſociation of ingenious men in this country, which finally iſſued in the eſtabliſhment of the Royal Society. From that period, ſimilar inſtitutions were formed in moſt of the enlightened countries in Europe; kings and miniſters thought their glory concerned in appearing as the patrons and founders of them; and men of ſcience enrolled among their aſſociates names the higheſt in rank and office. But thoſe inſtitutions which have had their origin in the commands of civil power, have been few in proportion to the ſpontaneous fraternities of perſons attached by ſimilarity of ſtudies, which, eſpecially of late years, have rapidly ſpread wherever knowledge has charmed the human mind: and the European ſpirit of improvement has now penetrated, with the colonies and arms of Europe, to diſtant quarters of the globe, and is throwing into a common fund the knowledge and inventions of Aſia and America, with thoſe of the parent regions.

The advantages which have been derived from learned ſocieties have already been very great; for although few of them have done much in what ſeems originally to have been a leading object—the united purſuit of diſcoveries as a body (a mode more ſplendid in appearance than practically uſeful);—yet they have afforded great ſupport and encouragement to individuals in their inveſtigations; and have been the means of preſerving, and offering to the world in a ſtable and reſpectable form, many moſt valuable papers, which without ſuch aid would either have remained locked up in the cabinets of the writers, or have dropt from the preſs unnoticed and forgotten. It is an acknowledged fact, that many of the moſt uſeful diſcoveries and improvements in art and ſcience have been uſhered into the world through the medium of the periodical publications of ſocieties: and no man can flatter himſelf with a complete acquaintance with what has been done and is doing in any one branch of knowledge, without having informed himſelf of the contents of theſe works.

But ſuch is now the number of them, and ſo various the places of publication, and the languages in which they are written, that a private ſcholar, eſpecially in this detached part of Europe, finds it an extremely difficult matter to obtain and peruſe them. On this account, many perſons have expreſſed a wiſh that they might be enabled in leſs compaſs, and with leſs trouble and expence, to obtain an adequate acquaintance with theſe ſources of knowledge. This want it is the object of the conductors of the preſent publication to ſupply. By confining their attention ſolely to works of this claſs—the Memoirs and tranſactions of learned and œconomical Societies—they will have it in their power to afford more complete information concerning them, than can be done in Journals which embrace the whole of literature. Indeed, they ſhall not ſatisfy themſelves without giving ſuch a full view of theſe collections, as may aſſure every enquirer after knowledge who ſhall read their publication, that nothing of importance has been withheld from his view. It is their plan to notice *every* article in all the principal publications of the kind throughout the learned world; to give analyſes of them proportioned to their conſequence; and to print at large ſuch as are at the ſame time intereſting and incapable of abridgment. Where plates and tables are neceſſary to convey clear ideas, they will be copied. They do not pretend to render the original works uſeleſs—that would be equally unfair in the attempt, and preſumptuous in the idea—but they will acknowledge their work defective, if it fail of ſupplying every material link in the chain of uſeful and curious knowledge. With reſpect to the arrangement of their materials, it is impoſſible to lay down any preciſe plan. They muſt take works in the order they come to hand. As numerous difficulties occur in procuring foreign books in this country, it may happen, notwithſtanding their beſt diligence, that they for ſome time fall in arrear with reſpect to them, and that in ſome of their earlier numbers, domeſtic publications occupy more than their proportional ſhare.

On the whole, as their attempt can claim no merit but that of utility, they ſhall place all their expectations of public encouragement in rendering it as uſeful as poſſible.

A Catalogue af Publications which come within the Plan of the preſent Work.

England.——Philoſophical Tranſactions.—Antiquarian Society, London.—Tranſactions of the Society of Arts.—Tranſactions of the Linnæan Society.—Tranſactions of the African Aſſociation.—Mancheſter Memoirs.—Bath Society of Agriculture.

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Sweden.——Acta ſocietatis regiæ ſcientiarum Upſalienſis.—Kengl. Vetenſkaps Academiens handlinder, Stockholm.

Denmark.——Royal Academy of Sciences at Copenhagen.—Royal Icelandic Society.

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Switzerland.——Acta Helvetica, Baſil.—Adhandlungen der Naturforſchen den Geſellſchaft, in Zurich.—Memoires de la Societé des Sciences Phyſiques de Lauſanne, à Lauſanne, 4to.

Holland.——Der Hollandſchen Geſellſchaft der Wiſſenſchaften, zu Haarlem, Abhanglungen, Altenb.—Society of Agriculture at Amſterdam.—Verhandelingen van het Bataafich Genootſchap der profondervindelſe Wiſbegierde, Rotterdam. Verhandelingen uitgegeven door heet Zeeuwſch Genootſchap der Wetenſchappen te Uliſſingen.—Medical Society of Amſterdam.

America.——Tranſactions of the Society at Philadelphia.

Eaſt-Indies.——Tranſactions of the Aſiatick Society at Bengal.

The Proprietors will be obliged to any Gentleman to inform them of any omiſſion in the above Liſts.

ME-

MEMOIRS

OF

SCIENCE AND THE ARTS.

ASIATICK RESEARCHES, 4to. *Calcutta*, 1788.

IN the introduction, the candour of the public is requeſted for this firſt publication, as being the work of men who cannot allot their whole time to philoſophical or literary purſuits, but are chiefly employed in the buſineſs of their profeſſions; being a number of Engliſhmen, who were of opinion, that a ſociety inſtituted at Calcutta, on the plan of thoſe eſtabliſhed in the principal cities of Europe, might be a means of concentrating all the valuable knowledge, which could occaſionally be obtained in Aſia, and of preſerving many little tracts and eſſays, not of ſufficient importance for ſeparate publication. For this purpoſe, a ſociety was formed on the fifteenth of January, 1784. They begin by declaring, that they will paſs no deciſion in their collective capacity, on any point of literature or philoſophy, but that the writers muſt be individually reponſible for their own opinions.

At the firſt meeting, it was reſolved to apply to the Governor and Council (as the executive power of the country) for their patronage, which was immediately granted. Application was alſo made to Mr. Haſtings, then Governor-general, to become Preſident, which he declined, but recommended the gentleman who planted the inſtitution, (Sir William Jones), who was accordingly nominated, and who at the firſt meeting, delivered a *Diſcourſe* on the inſtitution of the ſociety, to the following purport.

" When on my voyage to this country, I found one day by the obſervation, that India lay before us, Perſia on our left hand, and that a breeze from Arabia blew on our ſtern. A ſituation this, which awakened a train of reflections in my mind, to find myſelf almoſt encircled by the vaſt region of Aſia, the nurſe of ſciences, the inventreſs of arts, and ſcene of glorious actions; fertile in the productions of human genius, abounding in natural wonders, and diverſified in the forms of religion, government, laws, manners, languages, features and complexions of men. I remarked an extenſive field yet unexplored, and many ſolid advantages unimproved, and conſidered that ſuch enquiries and improvements could only be made by the united efforts of many; but I conſoled myſelf with a hope that, if in any country ſuch a union could be effected, it was among my countrymen in Bengal.

" You, gentlemen, have realized that hope, by founding a ſociety for enquiring into the hiſtory and antiquities, the natural productions, arts, ſcience, and literature of Aſia,

Aſia. Such an inſtitution will advance to maturity by ſlow, yet certain degrees. To enſure ſucceſs and permanence, we muſt avoid a languid remiſſneſs, or over-zealous activity, and I take the liberty to ſubmit a few general ideas to the ſociety.

"I conceive it is your deſign to take an ample ſpace for your inveſtigations, bounding them only by the geographical limits of Aſia. So that conſidering Hindoſtan as a center, and turning to the north, you have on the right many important kingdoms, China, her Tartarian dominions, Japan, and the cluſter of iſlands; before you, that chain of mountains, which formerly were, perhaps, a barrier againſt the ſea; beyond them, Thibet and Tartary: on your left, the beautiful provinces of Iran or Perſia, the unmeaſured deſerts of Arabia, the kingdom of Yamen, and the iſles ſubdued by the Arabs; and weſterly, the Aſiatic dominions of the Turks. But ſince Egypt has an old connection with this country, ſince the language and literature of Abyſſinia have an affinity with that of Aſia, and the Arabian arms have prevailed along the African coaſt of the Mediterranean, you will perhaps follow the ſtreams of Aſiatic learning ſomewhat beyond its natural boundary. As a name to this ſociety, that of Aſiatic appears to me, therefore, preferable to Oriental.

"The objects of our enquiries are MAN and NATURE; whatever is performed by the one, or produced by the other. Human knowledge has been elegantly analyſed according to the three great faculties, *memory*, *reaſon*, and *imagination*; and hence the three main branches of learning are hiſtory, ſcience, and arts. Agreeably to this analyſis, you will inveſtigate what is rare in the ſtupendous fabric of nature; will correct the geography of Aſia by new obſervations; will trace the annals of the nations who have peopled or deſolated it, their government and inſtitutions, ſciences and arts. As to the languages, which I have ever conſidered as the mere inſtruments of learning, the attainment is difficult, but neceſſary; and if to the Perſian, Arminian, &c. we could add the Shanſcrit, Chineſe, Tartarian, Japaneſe, &c. an immenſe mine will open, in which we may labour with delight and advantage.

"Having ſubmitted my thoughts on the *limits* and *objects* of the ſociety, I will add a few hints on the conduct.

"In the infancy of any ſociety, there ought to be no unneceſſary trouble, expence, or formality. Let us have weekly evening meetings, for hearing original papers read. Let all the curious and learned be invited to ſend in their tracts; and if, at the end of the year, they will make a volume, let us preſent it to the world. You will not, perhaps, admit tranſlations, except from unpubliſhed eſſays. When you will enrol as members, you will hereafter decide, but you will, I preſume, determine, that all queſtions ſhall be decided by ballot, by the majority of two thirds, and that nine members ſhould conſtitute a board; and I recommend, on no account to admit a new member who has not expreſſed a deſire to become ſo.

I. *A Diſſertation on the Orthography of Aſiatick Words in Roman Letters.*

By the PRESIDENT.

THE Preſident obſerves, that whoever compoſes tracts on Aſiatick literature, or tranſlates from the Aſiatick languages, will find it neceſſary to expreſs Arabian, Indian, &c. words in European characters; that no complete ſyſtem has appeared, ſo that each ſound may be rendered by one appropriated ſymbol, conformably to articulation, and with a due regard to the primitive power of the Roman alphabet.

Mr. D'Herbelot abounds in citations from the writers of Arabia and Perſia, yet it requires a moderate knowledge of Perſian, Arabick, &c. to comprehend the paſſages quoted by him in European characters.

In the account of Ibnu Zaidùn, an Andaluſian poet, the firſt couplet is expreſſed in Roman letters:

Iekad heïn tenagikom dhamairna;
Iacdha âlaïna alaſſa laula taſſina.

"*The time,*" adds the tranſlator, "*will come, when you will deliver us from all our cares; the remedy is aſſured, provided we have a little patience.*" When ſome perſons, at the preſident's requeſt, attempted to write the ſame in Arabick characters, they all wrote it differently. He gueſſes the diſtich ſhould be thus written:

Yecádu hhína tunájícum demáyeruuà
Yakdì âlainà 'láſay lau là taáſsínà.

"*When our boſoms impart their ſecrets to you, anguiſh would almoſt fix our doom, if we were not mutually to conſole ourſelves.*"

The preſident aſks, if ſuch perplexities would ariſe, if M. D'Herbelot, or his editor, had formed a regular ſyſtem?

As a further proof he remarks, that a learner of Perſian, who would wiſh to write the name of Sultan Azim in the Arabick characters, might expreſs it *thirty-nine* ways, and yet be wrong: the word ſhould be written *Aâzem*, with three points on the firſt conſonant.

There are two modes of exhibiting Aſiatick words in our letters; the firſt regards the *pronunciation*, and this method is uſeful, but precarious; beſides, all grammatical analogy is deſtroyed, ſimple ſounds are repreſented by double characters, vowels of one denomination ſtand for another, and poſſibly we perpetuate a bad pronunciation, as in writing *Kummerbund*, where neither the letters or true ſound is preſerved, but *Kemerbend*, as an ancient Briton would write it, exhibits the original characters and Perſian pronunciation. The ſecond ſyſtem conſiſts in ſcrupulouſly rendering letter for letter.

For the firſt method, the warmeſt advocate was the late Major Davy; he valued himſelf on his new way of exhibiting Perſian in our characters; but he ſpells moſt names in a manner that a Perſian would be unable to comprehend. His method neither renders the original elements of the words, nor the ſounds repreſented by them in Perſian.

The ſecond method is ſupported by Mr. Halhed and Mr. Wilkins. In Mr. Halhed's ſyſtem, the preſident is diſſatisfied only with the uſe of double letters for the long vowels, and in the intermixture of *Italic* and *Roman letters*. Mr. Wilkins's ſyſtem principally conſiſts of double letters, to expreſs our third and fifth vowel, and of the proſodial marks to aſcertain their brevity and length. The preſident approves this notation for Shanſcrit, yet requires ſomething more univerſally expreſſive of Aſiatick characters.

He then proceeds to explain his own ſyſtem, and laments that we ſhould begin our education in England, by learning to read *the five vowels*, *two* of which, as we pronounce them, are clearly dipthongs. There are indeed five ſimple ſounds in our language, which occur in the words *an innocent bull.* Theſe are all ſhort vowels, which an Italian would pronounce as in his own language, *ſà, ſi, ſò, ſe, ſù.* Between theſe there are numberleſs inflations, forming many dipthongs and tripthongs, many of which are found in Italian; but in this paper we ſhall have occaſion for two only, the firſt vowel with the third and the fifth; as to the vocal compounds, which begin with the third and fifth vowel, they are generally rendered by diſtinct characters, improperly ranged among the conſonants.

He next conſiders thoſe leſs muſical ſounds, which require the aid of a vowel to be articulated.

By the aſſiſtance of the tongue and palate we produce two ſounds, differing only as *hard* and *ſoft*, and if, when they are uttered, the breath be hardly protruded, two analogous articulations are heard, the ſecond of which characteriſes the pronunciation of the Arab, and the naſal ſound is common among the Perſians and Indians. Next comes the *dentals*, among which are the *ſibilants*; each dental by thruſting the tongue between the teeth forms two ſounds very common in Arabick and Engliſh, but change into liſping ſibilants by the Perſians and French. The *liquid naſal* follows theſe, and in the Indian dialect moſt ſounds of this claſs are varied in a ſingular manner, by bending the tongue upwards towards the palate. The *labials* form the laſt ſeries, and the preſident thinks a *natural character* for articulate ſounds might be agreed on by delineating the ſeveral organs of ſpeech, in the act of articulation, and ſelecting from each a diſtinct and elegant outline. A perfect language would be that, in which every idea ſhould be expreſſed in one word, ſimple, if ſimple, complex, if complex; and a ſyſtem of letters ought to contain one ſpecific ſymbol for every ſound: in this reſpect old *Perſian* or *Zend* approaches to perfection; and the Arabian alphabet appears ſo complete for writing Arabick, that not a letter could be added or taken away; the ſame may be ſaid of the *Dévanágarì* ſyſtem, which is the ſtandard of Sir William's obſervation on Aſiatick letters. Our Engliſh alphabet is imperfect, and it would be impoſſible to expreſs either Indian, Perſian, or Arabian words in Roman characters, as we pronounce them; new characters would be inconvenient, but by the help of a diacritical mark uſed by the French, with a few of thoſe adopted in our *fluxions*, we may apply our preſent alphabet ſo happily to the notation of all the Aſiatick languages, as to equal the *Dévanágarì* itſelf in clearneſs and preciſion.

No. 1. Is the firſt vocal ſound, the proper ſymbol is A. though often conveniently expreſſed by E. The *Nágarì* letter is called *acàr*, is pronounced in Bengal like our fourth vowel, and in the weſt of India like our firſt: in all dialects properly Indian, it is conſidered as *inherent* in every conſonant, and is placed laſt in the ſyſtem of the *Tibetians*. This letter anſwers to the *fat-hhah*, or open ſound of the Arabs, or the *zeber* of the Perſians, but this Arabian mark, or acute accent above the letter, is pronounced at Isfahan like our firſt or ſecond ſhort vowel, as in *chaſhm* and *ferzend*, the diſtinction ſeems to depend in the nature of the conſonant. Two of our letters are neceſſary to complete the notation of the *acàr* and *zeber*.

2. When the firſt vowel, as the Perſians pronounce it in *bakht*, is doubled or prolonged as in *bàkht*, it has the ſound of the ſecond *Nágarì* vowel, and the firſt Arabick letter, or of our long vowel in *caſt.* Its natural mark ſhould be a ſhort A doubled,

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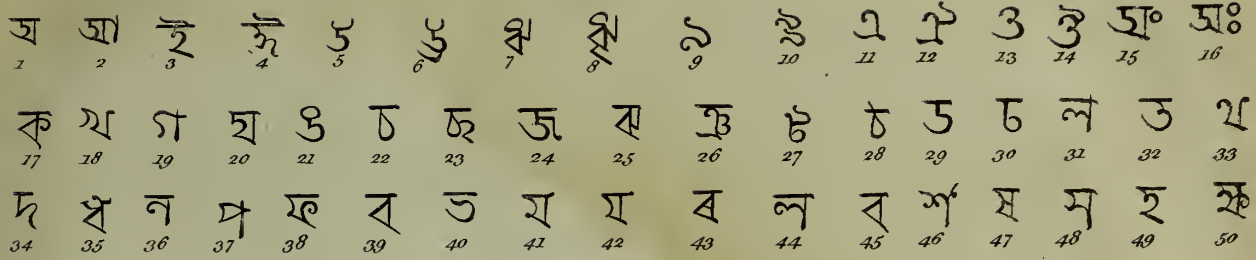

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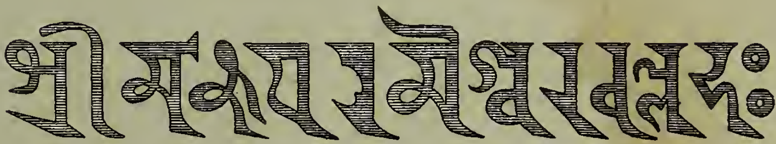
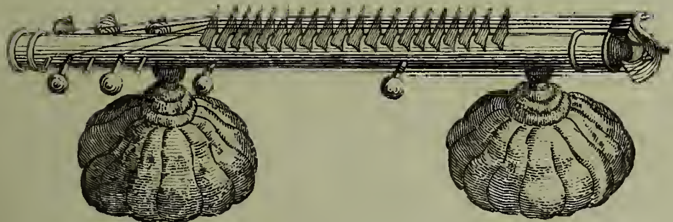


BEEN *or* VINA 3.



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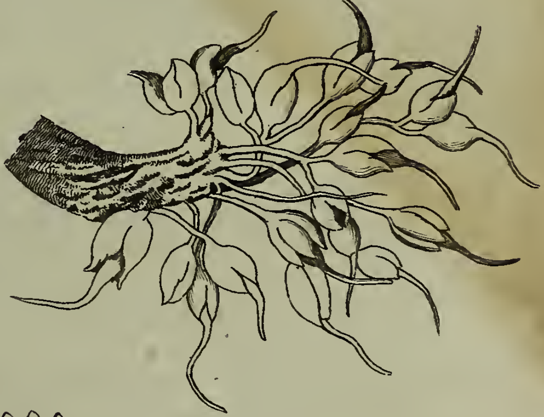

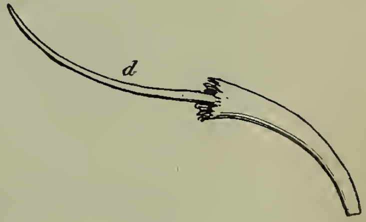

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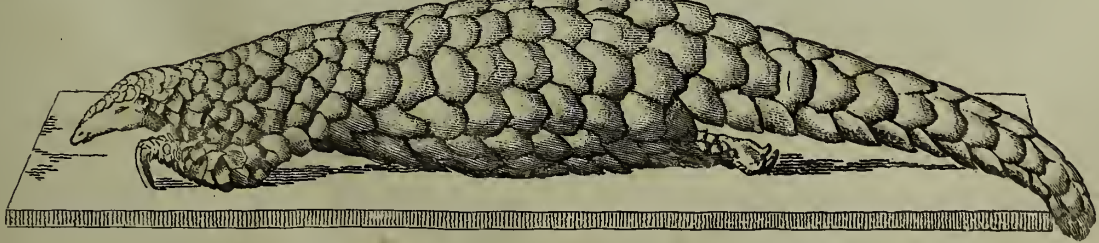

doubled, but an *acute* accent in the middle of words, or a *grave* at the end of them, will be equally clear. The broad ſound of the Arabian letter in *âſân*, may be repreſented by the proſodial ſign, ſince it is conſtantly long, whereas the mark *hamzah* ſhortens the letter, as in the words *óſúl* or *Iſlàm*. In writing Aſiatick words, we frequently confound the broad *à* with its correſpondent ſhort vowel, which we improperly expreſs O, as we write *coſſim* for *kàſim*, in defiance of analogy and correctneſs; our vowel in *fond* occurs but ſeldom, if ever, in Arabian, Indian, and Perſian words.

3. Our third vowel, correctly pronounced for our ſecond ſhort vowel, has no place in the Nágarì ſyſtem. This in Arabick is repreſented by an acute accent *under* the letter, but ſince in the *Zend*, a character like the Greek *E-pſilon*, repreſents our ſecond and third ſhort vowels, the Perſians pronounce *zìr* like *zeber*, calling this country *Hend*, and the natives *Hendus*: nevertheleſs it will be proper to denote the Sanſcrit *icàr* and the Arabian *caſr*, by one unaltered ſymbol, as in the words *Indra* and *Imam*.

4. The third vowel produced or lengthened, beſt marked by an accent, either acute or grave.

5. This is our fifth vowel: for our fourth ſhort one is rejected from the pure Sanſcrit in the weſt of India, and at Bánáras, though the Bengàleſe retain it in the firſt Nágarì letter, which they call *ocar*; to the notation of this ſound, our vowel in *full* ſhould be conſtantly appropriated. It anſwers to *hu-pſilon*, and like that is often confounded with *iota*: thus *muſhc* is pronounced *miſhc* among the Perſians. The *damm* of the Arabs, is, however, frequently ſounded like our ſhort O in *memory*.

6. The ſame lengthened, and properly expreſſed by an accent, as in the word *vírtù*; it is very long in Perſian, ſo as to treble the quantity of the ſhort one, as is the caſe with all the Isfahan long vowels, but the letter *vâû* is often redundant, ſo as not to alter the ſound of the ſhort vowel preceding it, as in *khóſh and khód*; it may, however, be right to expreſs that letter by an accent.

7. A vocal ſound peculiar to the Sanſcrit language, formed by a vibration of the tongue preceding our third vowel, and may be expreſſed by the proſodial mark as in *Rĭſhi*; we have a ſimiliar ſound in the word *merrily*, the ſecond ſyllable of which is much ſhorter than the firſt ſyllable of riches.

8. The ſame complex ſound lengthened, and therefore diſtinguiſhable by the proſodial ſound of a long vowel.

9. In Bengal this letter expreſſes both ſyllables of our word *lily*, but its general ſound is *lṛi*, a ſhort dipthong peculiar to the Sanſcrit.

10. An elongation of the former.

11. Our ſecond vowel, beſt repreſented by an accent, as in *Véda*.

12. A diphthong of the firſt and third vowels, and expreſſible by them, as in the word *Vaidya*; in Bengal it is pronounced as the Greek *poimèn* was probably ſounded. The Arabs and Engliſh articulate this compoſition exactly alike.

13. Though a coalition of *acar* and *ùcar* forms this ſound in the Sanſcrit, it is in fact the fourth of our long vowels.

14. A proper dipthong, compoſed of our firſt and fifth vowels, and in Perſia, as in Italy, the conſtituent ſounds are not united.

15. Is no vowel, but an abbreviation at the end of a ſyllable, of a naſal conſonant; as the Portugueſe write *Siao* for *Siam*, with a naſal termination. It appears to me

that we cannot do better than adopt the Indian method of diſtinguiſhing it in the Sanſcrit, Chineſe, and Perſian words, by a point above the letter, as in *Siṅha* a lion.

16. Alſo an abbreviation or ſubſtitute for the ſtrong aſpirate at the cloſe of a ſyllable, and may be diſtinguiſhed in the middle of a word by a hyphen, as in *duh-c'ha*, pain, though it ſeems to reſemble the Arabian *hà*, which only gives a more forcible ſound to the vowel which precedes it, as in *hhiemah*, ſcience. When ſuch Arabick words are uſed in conſtruction, the final aſpirate of the firſt noun has the ſound of *tà*, but it ſhould I think be deſcribed in our characters by two points above it, as in Arabick, ſince if we write *Zubdahu' lmulc*, with a comma to denote the ſuppreſſion of the *alif*, every learner will know that the word ſhould be pronounced *Zubdat*. The *ha* ought invariably to be inſerted, as in *Shánámah*, ſince the aſpiration is perceptibly ſounded in the true pronunciation. The Sanſcrit character before us has the ſingular property of being interchangeable by certain rules, both with *ra* and *ſa*, as *arbos* was uſed in Latin for *arbor*.

17. The firſt proper conſonant in the Indian ſyſtem. This letter has the ſound of our *k* or *c*, in *king* or *cannibal*, but is beſt expreſſed by the laſt. The Arabs have a letter ſounded near the palate with a hard preſſure, as in *K'áſim*; this we ſhould diſtinguiſh invariably by *k*, and we ſhall find the utility of appropriating *c* to the notation of the Indian letter. The third Roman letter was probably the *kappa* of the Greeks, and we may fairly pronounce that *Cicero* and *Cithara* were pronounced alike at Rome and Athens. The Welch apply the ſame ſound to *Cae* and *Cefn*.

18. The only proper aſpirates (with a ſtrong breathing) are to be found in India; this aſpiration may be diſtinguiſhed by a comma, as the letter before us, *c'hanitra*, a ſpade. The Arabian, Perſian, and Tuſcan aſpirate may be written as the word *makhzen*, a treaſure.

19. Should be conſtantly expreſſed as in the word *gul*, a flower, *gil*, day.

20. Is the aſpirate of the laſt letter, as in the word *Rag'huvanſa*; the Perſians and Arabs pronounce this *ghain*, with a bur in the throat, or a tremulous motion of the tongue, as the *r* is pronounced in Northumberland. *Gaza* ſhould be written *Ghazzah*, and the French word *gazelle* ſhould be written *ghazàl*, the antelope of the Arabians. The Perſian word *mígh*, a cloud, is *míg'ha* in Sanſcrit, as *míſh* appears to be derived from *míſha*, by a change of long vowels which diſtinguiſh the Iranian from the Indian pronunciation.

21. A naſal palatine, which the preſident propoſes to denote by a point above the letter *n*, as the addition of a *g* would create confuſion.——Thus ends the firſt ſeries of Nagari letters, conſiſting of hard and ſoft gutterals, each attended by its proper aſpirate, and followed by a naſal of the ſame claſs: an arrangement continued as far as poſſible through the Sanſcrit ſyſtem, and ſeems conformable to the beautiful analogy of nature.

Next proceeds a ſeries of compound letters, as ſome grammarians conſider them.

22. The firſt has no diſtinct ſign in our alphabet, which is expreſſed, as in the word *China*, by two letters, which are certainly not its component principles, but might perhaps be more properly denoted, as in M. D'Herbelot's works, by *tſh*.

23. The ſame compoſition, with a ſtrong breathing articulated after it, and ſhould be expreſſed as in the word *ch'handa*, metre.

24. This the Hindoos conſider as a ſimple letter, but appears to be the complex expreſſion of *dzh*, perhaps it has two ſounds. It is confounded as a ſimple ſound

with *ya,* and as a compound with *za,* one of its conſtituents; thus the *yaſmin* of Arabia is by us called *jaſmen*; as the *yug* or *junction* at Benares is called *jug* at Bengal, and was pronounced *zug* at Athens. We ſhould invariably expreſs this letter by *ja.* The Arabian letters *'dhal, 'dàd,* and *dhà,* are all pronounced in Perſia *za,* with a ſort of liſp, and may be expreſſed as z with one, two, or three points over it.

25. The preceding letter aſpirated, as in *J'haſha,* a fiſh.

26. The ſecond naſal, compoſed of the former and the letter *ya,* as the Italian *agnello* and our *onion* contain a compoſition of *n* and *y,* and the Indian ſound only differs from the greater naſality of the firſt letter, and may be diſtinguiſhed by a point. A Sanſcrit word ſignifying *to know,* begins with the letter *ja,* and ſhould be written *jṅyà,* but in Bengal this is ſoftened into *gyà,* and is expreſſed by a diſtinct character.

27. In a curious work called the *Preſent of India,* this is the fourth ſeries, but in general has the third rank in Sanſcrit letters. The firſt is the India *ta,* or the Arabian *tà,* which it nearly reſembles.

28. The ſame, with a ſtrong breathing.

29. A letter called by the Muſlimans the Indian *dál,* and ſhould be diſtinguiſhed by an accentual mark, as in the word *dúnda,* puniſhment. It reſembles the Arabian *'dád.*

30. The preceding letter aſpirated, as in *D'haca,* improperly pronounced *Dacca.* In the ſame manner may be written the Arabian *'dhá,* but without a comma, ſince its aſpirate is leſs diſtinctly heard than in the Indian ſound.

31. The naſal of the third ſeries, and formed by a ſimilar inverſion of the tongue; in Sanſcrit words it follows the letters *ra* and *ſha,* as *Bráhmena, Viſhnu,* and precedes the other letters of the third claſs.

32. Begins the fourth claſs, and is the common *ta.*

33. Its aſpirate, which ought to be written with a comma, as in *Aſwatt'ha,* (the Indian fig-tree) leſt it be confounded with the Arabian ſound in *thurraya,* which is like our word *think*; a ſound the Perſians and French cannot imitate. In Perſian it ſhould be expreſſed by *s* with a point above it.

34. The ſoft dental, as in *Dévatà,* or Deity.

35. The ſame aſpirated, as in *D'herma,* juſtice. It ſhould be diſtinguiſhed by a comma from the Arabian, in *dhatab,* gold. A ſound we write *thus* very improperly, inſtead of retaining the genuine Anglo-Saxon letter, and expreſſing it *dhus.*

36. The ſimple naſal, ſounded by the teeth, with a little aſſiſtance from the noſtrils, as in *Náráyená.*

Next come the labials, and [37] is the firſt hard labial *pa*; this the Arabs articulate with great difficulty.

38. Is the aſpirate of *pa,* but often pronounced like our *fa.* In truth the *fa* is a diſtinct letter, and *pha,* which in Engliſh is redundant, ſhould be appropriated to this.

39. The ſoft labial in *Budd'ha,* wiſe, and the ſecond letter in moſt European alphabets.

40. The aſpirate of the above, as in *bháſhá*; no comma is neceſſary here.

41. The laſt naſal, as in *Menu*; it it formed by cloſing the lips entirely, while the breath paſſes gently through the noſe. Here ends the regular Nagari letters. Another ſeries might have been added, namely, *ſa, ſha, za, zha,* which are in the ſame proportion as *ta, ſha, da, dha,* and the reſt, but the two laſt ſounds are not uſed in the Sanſcrit. Then follows a ſet of letters approaching the nature of vowels; the firſt,

42. Seems our third ſhort vowel beginning a dipthong, and may be called a ſuperfluous character; it is ranked by many among the conſonants, and confounded with *ja*; hence *Yamuna*, a ſacred river in India, is written *Jomanes* by the Greeks, and *Jumna* leſs properly by the Engliſh.

43. The two liquids *na* and *ma* are kept apart to preſerve the analogy of the ſyſtem, and the other is introduced between the two ſemi vowels; the firſt of theſe is *ra*, as in *Rama*.

44. The ſecond is *la*, as in *Lanca*.

45. When this character correſponds, as it ſometimes does in Sanſcrit, with our *wa*, it is in fact our fifth ſhort vowel preceding another in form of a dipthong, and may eaſily be ſeparated; but when it has the ſound of *va*, it is a labial. The Bengaleſe confound it with *ba*, from which it ought to be carefully diſtinguiſhed. The *vaw* of the Arabs is always a vowel, but in Perſian is a conſonant, and pronounced like our *va*, with rather leſs force. Then follow three ſibilants, the firſt

46. Is called in India *ſa*, and ſhould be pronounced as in *palâſa*, as ſhould the *ſad* of the Arabs and Hebrews; except that in Caſmir and the bordering provinces, it is hardly diſtinguiſhed from

47. Which is improperly written *ſha* by us, and *cha* more erroneouſly by the French. This letter, of which *ſa* and *ha* are not the component parts, is formed ſo far back in the head that the Indians call it a *cerebral*; either it was not articulated by the Greeks, or they choſe to expreſs it by their *xi*, ſince from the Perſian word *Ardaſhir* they have formed *Artaxerxes*.

48. The dental *ſa*, reſembling the Hebrew letter of the ſame ſound.

49. Is the ſtrong breathing *ha*.

50. The Indian ſyſtem cloſes with a compound of *ca* and *ſha*, as in the word *paricſha*, and is analogous to our *x**. The Bengaleſe give it the ſound of *cya*, or of our *k* in *kind* and *ſky*. The Greeks rendered this letter by their *khi*, changing *Dacſhin* into *Dakhin*.

The ſingular letter of the Arabs *Ain*, is placed immediately before the conſonants. It might be claſſed among the naſals of the Indians, but in Arabia and Perſia it has a different ſound, of which no verbal deſcription can give an idea, and may be called a naſal; it is univerſally diſtinguiſhed by a circumflex above the ſhort vowel, or over the letter preceding a long one, as *îlm*, learning, *âalim*, learned.

Sir William annexes ſome ſpecimens of Oriental writing, as examples of the method he recommends.

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* See Plate I. Fig. 1, where theſe Characters are delineated.

II. *Aſtronomical Obſervations. By Col.* Thomas Pearse, *Commander of Artillery in Bengal.*

THE clock uſed by Col. Pearſe was made by Ellicot; it beat dead ſeconds; with one hand for minutes, and the hours revolve, with the plate fixed to the whole wheel; the pendulum is deſcribed in Phil. Tranſ. Vol. XLVII. p. 479. The tranſit inſtrument by Siſſon, four feet long, with a double object glaſs, the meridian mark 1500 yards diſtance. A Hadley's quadrant was uſed with quickſilver till December, 1776, then an 18 inch land quadrant by Ramſden, with a micrometer to ſubdivide the nonius, this inverts and is capable of the niceſt adjuſtments; the firſt teleſcope was an 18 inch reflector by Gregory, till Auguſt, 1777, then a reflector of Dollond's, with a triple object glaſs, and a double object glaſs micrometer; the time-keeper was by Brookbank, which goes whilſt it is wound up, and is tolerably good.

By obſervations for determining the longitude of the Obſervatory at Fort William from Greenwich; the longitude in time, from various obſervations of Jupiter's ſatellites, mean of all was 5*h.* 54′ 17″,64.

1776. December 23. Jupiter's 1ſt ſatellite at the edge of the limb, apparent time, 11*h.* 53′ 25″. in contact emerged 11*h.* 58′ 53″

1779. May 2. Jupiter's 1ſt ſatellite immerged into the diſk, 11*h.* 35′ 50″,6.

"If the immerſions and emerſions of this nature were calculated, ſo as to ſet aſtronomers to look out for them, the ſatellites might be rendered more uſeful in regard to longitudes by land, whether the calculations are accurate or erroneous: for I mean to uſe an immerſion or emerſion of any kind, only to note an inſtant for taking the altitude of Jupiter at the place of obſervation; if the eyes be of equal ſtrength, and the inſtruments of equal powers, the altitudes will be taken by every perſon who ſhall obſerve at one and the ſame time, and thence the diſtance of Jupiter from the meridian of each will be known to ſeconds, if we ſuppoſe the latitudes known beforehand; and if the teleſcopes of quadrants could be made ſufficiently powerful, then a ſimple obſerver at any place would perform the whole without trouble or difficulty, and would only need a common watch and a little more patience, than would be requiſite if the watch was perfect, and calculation true. By this mode a degree of longitude may be meaſured with as much accuracy as a degree of latitude.

"In 1778, I took notice that when Jupiter is very near the oppoſition, the obſervations are not to be depended on, and that the ſatellite vaniſhed without changing colour; the ſame happened in 1779 and 1780; perhaps Jupiter's atmoſphere may be ſo denſe as to prevent the free paſſage of the diminiſhed light ſoon after the beginning of an eclipſe, or even before it, if ſo, the difference of obſervations in the oppoſitions and in the quadratures may tend to clear up that point, and to meaſure the extent of that atmoſphere."

The mean longitude in time, from ſix obſervations of Jupiter's 1ſt ſatellite, from February 4, 1778, to March 13, 1780, all near the oppoſition, 5*h.* 51′ 16″,9.

Obſervations of Venus. 1777. July 14. Venus paſſed the meridian 21*h.* 1′ 2″. Diſtance from ☉'s center [42° 13′] 21*h.* 23′ 33″:5. 15th, paſſed meridian at 20*h.* 59′ 29″. 16th, paſſed meridian at 20*h.* 58′ 8″:5.

1780. March 18. An appulſe of Venus to Mars. [The micrometer is read off to the 500th part of an inch]

Diſtances,	15′ 17″,2	Apparent time,	7*h.* 39′ 33″,9
	15 20 ,9		7 44 33 ,9
	15 18 ,7		7 49 33 ,9

19th, difference of declin. 26′ 8″,7, at 7*h.* 41′ 51″,4. Diff. of Æ 0*h.* 2′ 7″. Mars was ſouth of Venus.

1775. January 12. Immerſion of Aldebaran behind the moon, 8*h.* 54′ 55″.

February 15. End of a lunar eclipſe, apparent time correct, 10*h.* 15′ 0″, 5.

Occultation of Regulus. 1776. March 3. The tranſit inſtrument being yet without a meridian mark, it was adjuſted in other reſpects, and the tranſits of ſeveral ſtars were taken to determine its poſition, and the error of the clock. Col. Pearſe then inſerts a rule for determining the true poſition of the teleſcope and the error of the clock in ſuch caſes of doubt, which Mr. Reuben Burroughs had before inſerted in the Ladies Diary.

ζ and γ Leonis were the two ſtars relied on for time and poſition, becauſe they paſs at nearly equal diſtances from the zenith, and the mean of their errors of the clock would be very nearly the true error.

The difference of their errors was 5″,6; and thence the error of the tranſit inſtrument was 1246″,16 at the horizon, and the intervals of the wires 1478″.

3d March	Tranſit at Mid. Wire	Equation for Error of Inſtrument	Tranſit by Calculation	Error of Clock
	h ′ ″	″	*h* ′ ″	″
ζ Leonis	11 10 39	+ 3,01	11 4 00,6	+ 6 41,41
γ Leonis	11 14 08	— 2,59	11 7 24,0	+ 6 41,41
Immerſions of α Leonis	14 2 39:5			
6th March	----by equal	altitudes ——	————	+ 5 58,15

1776. July 30. Moon eclipſed, beginning of total darkneſs, apparent time, 17*h.* 1′ 16″.

1777. January 20. Immerſion of ζ Geminorum behind the moon, apparent time, 13*h.* 37′ 31″,6.

January 23. Eclipſe of moon began, 8*h.* 41′ 27″,7. End, 11*h.* 33′ 33″,5. ☽'s center on meridian, 12*h.* 4′ 30″,5.

February 13. Immerſion of μ Ceti behind the ☽. 7h. 53′ 46″,7. Five ſeconds before the immerſion, the ſtar began to change colour, and to loſe light ſenſibly; one ſecond before the immerſion, it was conſiderably broader and redder than at firſt, this ſupports the ſuppoſition of an atmoſphere round the moon, though it does not extend to any great diſtance.

1777. May 16. ☽'s weſt limb on meridian, 7h. 59′ 50″,1. ν Scorpii ditto, 8h. 0′ 2″, 1. By the arch of the tranſit inſtrument, the ſtar was 10′ from the limb.

1779. May 1. An appulſe of ☽ to Mars and Saturn. Mars on meridian, 12h. 55′ 42″.
Saturn ditto — — — 56 34
☽'s eaſtern limb — — — 57 36
☽'s diſtance from ♄ near ♂ neareſt of ♄ = 28′ 26″,7 — 13 31 53,5

1779. November 23. Eclipſe of the ☽. Apparent times correct. Beginning, 12h. 2′ 38″,0. Total darkneſs, 13h. 1′ 41″,3. End, 15h. 42′ 00″,6

1780. Auguſt 5. Appulſe of ☽ to Jupiter. ☽'s weſt limb paſſed a meridian circle, 7h. 14′ 44″. Jupiter's center, 7h. 14′ 53″. Ditto, 7h. 25′ 06″. ☽'s weſt limb, 7h. 25′ 19″.

Miſcellaneous Obſervations. The difference of declination of Jupiter and the neareſt horn of the ☽ was, 9′ 1″,4, at 7h. 28′ 400″. Diſtance of the limbs, 14′ 33″,2, at 7h. 32′ 12″. 15′ 1″,5, at 7h. 35′ 36″.

Wungole or Ongole. 1782. November 14. Mean latitude from four double altitudes of the Polar ſtar, 15° 31′ 37″.

November 16. With the octant mean of his double altitudes of the ſun, about the meridian, gives latitude, 15° 30′ 24″.

1784. The latitude obſerved was, 15°. 29′ 16″. This is inſerted to bring to teſt the accuracy of the octant, it alſo ſerves to ſhew. that even the polar ſtar may be uſed to great advantage, and in theſe hot climates the ſtars only can be employed, for the ſun's heat at noon is really not to be borne.

Determinations of longitude from obſervations depending on the theory in the nautical almanack.

Trivatoore, mean of two of Jupiter's 1 ſt.	80° 50′ 56″,5
Madras, deduced, by Trigonometry	80 5 6
The Chief's gardens, Maſulipatam, by Jupiter's 1 ſt.	81 2 3
The flag, ditto, by Trigonometry from the laſt	81 2 33
Peddapoor from Jupiter's 1 ſt. very good	82 5 9
Koſſim Kotta, by Jupiter's 1 ſt.	82 57 0
Vizacpatam, by ditto, mean of three	83 14 44
Bemulwilſa, by ditto, mean of four	83 22 9
Vizianagaram palace, by Jupiter's 1 ſt. and 2d.	83 27 21
Narrainpoor, by Jupiter's 1 ſt.	83 22 42
Kalingapatam, by ditto	84 13 37,5
Iechápoore, by Lunar, eclipſe	84 50 34
Gangam camp, by Jupiter's 1 ſt.	86 24 15
Jehaujepoor, by ditto	86 24 15
Soobureka river camp, oppoſite Jelapoor, on Ballaſore ſide the river, by Jupiter's 1 ſt. and 2d.	87 11 52

Compariſon of obſervations for longitude, with correſponding obſervations at different places.

1779. November 23. Lunar eclipſe at Calcutta, compared with Greenwich, 88° 22′ 4″,5.

Jupiter's ſatellites, from the beginning of 1774, till the 27th of December, 1777, were obſerved with a middling 18 inch reflector, I allow 24″ to compare it with the large reflector at Greenwich, and 12″ for their refractor, the compariſon is from actual correſponding obſervations, except in two caſes, in which the Calcutta obſervations are one revolution later. The longitude of Paris and Stockholm are taken from Wargentin, Phil. Tran. Vol. 67, Lunden, from thirty three correſponding obſervations found in the ſame paper. Of Chiſlehurſt. from Wollaſton, Vol. 74. Of Geneva, Oxford, and Marſeilles, from Pigot, Vol. 68, and 76. Nagpoore and Churnagur, were communicated to me by Lieutenant Ewart, of the Bengal eſtabliſhment, who obſerved at each place a conſiderable time.

The mean reſult from ſix obſervations of Jupiter's ſatellites, compared with actual correſponding obſervations, made at Stockholm, Greenwich, Paris, Geneva, Oxford, Lunden, Chiſlehurſt, and Marſeilles, gives the longitude of Fort William, from the 14th of October 1774, to the 18th of December, 1779.

1782. September 21. Longitude of Ichapoore from Lunar eclipſe, compared with Nagpoore 84° 55′ 9″
October 9. Longitude of Koſſim Kotta, from Jupiter's 1 ſt. ſatellite, with Nagpoore 82 57 45
1784. September 5. Longitude of Beemulwilſa, from Jupiter's 1 ſt. ſatellite, compared with York, Greenwich, and Paris — — — 83 23 30
November 8. Longitude of Churiargar, compared with Kalingapatam — 84 8 36

The mean reſults of various obſervations for determining the latitude of the following places, taken by Col. Pearse *and Lieut.* Colebrooke.

Madras	14° 4′ 32″
Viperee	13 5 5,35
Trivatore	13 9 0,4
North ſide of Cortelare river	13 15 1,5
Arambacam	13 31 36
Akamapett	13 40 32
Akarumpauk	13 47 49
Nayrpett	13 56 8
Korware	14 5 12,6
Vinateechillum	14 19 57
North ſide of Pinnare river	14 28 50,9
Ollore	14 42 3,8
Mooaumillodooro	14 52 26,7
Ongole, properly Wungole	15 30 16,2
Chicoortee	15 35 2,2
Yenmunbender	15 35 44,5
Vantipollam	15 46 27,5
Baupetla	15 54 32
Chundole	16 0 15,2
Maſſulipatam	16 10 32
Sicacollum on the N. bank of the Kiſtna	16 12 3,8
Moodenore	16 24 43,8
Ellore	16 42 17,5
Soolaurum	16 56 9
Rajahmundree	16 58 43,9
Rajahnagur	17 4 35
Peddapore	17 4 35
Gooloopooloore	17 8 48,2
Tonding and Matoor	17 12 50
Suteawaurum	17 18 33
Ellmulchillee	17 33 14
Sobaurum	17 46 59,2
Beemulwilſa camp	17 54 15
Vizacpatam	17 41 45
Semachillum	17 46 22,8
Chintulwilſa	18 2 17,1
Brimſing	18 2 32,4
Narraïnpoore	18 5 19,1
Vizianagur Palace	18 6 20,5
Santipollum	18 49 12,4
Kundawilſa	18 6 1,3
Timargudha	18° 12′ 24″,2
Sciacole Camp	18 17 1
Kalingapatam	18 21 16,8
Kulliparoo	28 28 5,1
Coſſeboogaum	18 45 5,8
Kutwaul Talanb	19 3 0,5
Ichapoor	19 6 44,9
Burrampoore	19 18 56,8
Munſoor Cottah	19 17 6
Ganjam Fort	19 21 3
Ganjam Camp	19 23 31,8
Piaghu	19 28 50
Maloodee	19 32 36,2
Mainickpatam	19 42 13,2
Jaggernaut	19 48 10,7
Ahmetpoore	19 56 40
Peeply	20 7 51
Ballunta	20 17 39,5
Sowlagunda, near Kuttack	20 26 33,3
Koomereah river, north ſide	20 43 12,8
Jehaujepoore river, north ſide	20 51 57,3
Chorakootee	20 59 25,2
Raneeka Taulaub	21 6 46,7
Kaunſee Baunſe	21 13 54,8
Aumnulla	21 23 1,2
Daumdurpoor	21 36 27,8
Soobanreeka, at Rauje Gaut, on the Ballaſore ſide	21 45 18,5
Jellaſore camp	21 46 52,5
Dantoon camp	21 57 40
Khutnagur	22 3 50
Mokurrumpoor	22 13 29,2
Kaſſai river	22 22 11,4
Midnapoor fort	22 26 5,6
Bunpoor	22 26 41
Treaſury Gate, Fort William	22 33 10,50
Habra Gaut	22 34 18,1
Narraindeowul	22 38 30,1
Madapoor	22 46 16,5
Chunderbund	22 46 52,5

III. *A royal grant of land, engraved on a copper-plate, bearing date twenty-three years before Chriſt, and diſcovered among the ruins of Mongueer. Tranſlated from the original Sanſcrit, by* Charles Wilkins, *Eſq.*

After a pompous exordium, in which the lineage of *Deb Paul Deb* is traced, that prince makes a grant of the town of Meſeeka, in the province of Sree Nogor, or Patna.

IV. *An*

IV. *An inſcription on a pillar near Buddal. Tranſlated from the Sanſcrit, by* C. Wilkins, *Eſq.*

MR. WILKINS ſays he diſcovered a decapitated monumental column, in a ſwamp near a temple, dedicated to Hargowree, of which he made a drawing. It is formed of a ſingle ſtone, and a few feet above the ground is an inſcription, ſee a ſpecimen, Plate I. Fig. 2, which Mr. Wilkins has decyphered.

The language is Sanſcrit, and the whole is compriſed in twenty-eight metrical verſes, of various meaſures, and contains a high panegyric on one Sree Goorava Meeſra, of the Brahmin race.

V. *Some account of the ſculptures and ruins at Mavalipuram. By* Wm. Chambers, *Eſq.*

THESE monuments appear to be the ruins of ſome great city, ſituated cloſe to the ſea, between Covelong and Sadraſs. There was in 1776 a ſmall village adjoining which retained the ancient name.

A rock or hill of ſtone on which theſe works ſtand, is known to mariners by the name of the *Seven Pagodas*. The natives, whoſe language is the *Tamulic*, improperly called the *Malabar*, call it Mâvalipuram, which in Sanſcrit would be Mahabaliper or the *city of the Great Bali*: a hero famous in Indian romance. This hill of ſtone appears at a diſtance like an antique and lofty edifice. On approaching it to the north, many works of ſculpture appear, which ſeem to favour the idea of a petrified town, as fabled by credulous travellers. Proceeding round the foot of the hill next the ſea, is a pagoda 16 or 18 feet high, of a ſolid ſtone, which appears to have been cut out upon the ſpot; the ſtile of architecture is different from that now in uſe. Further on is a numerous troop of human figures in bas relief, larger than life, repreſenting the moſt remarkable perſons celebrated in the Mahâbharit. Theſe figures being expoſed to the ſea air, are much defaced. On the eaſt ſide of the great rock, is an excavation apparently made for a Chowltry, or accomodation for travellers; two or three pillars are left as a ſeeming ſupport to the roof, but much decayed, as in a ſculpture facing the entrance, the ſubject of which is Kriſhen attending the herds of *Nund Ghoſe*, the Admetus of the Hindoos.

Aſcending the hill to the north, which is gradual and eaſy in ſome places, and in others cut in ſteps, we find a kind of temple cut in the ſolid rock, with ſome idols in relief on the walls, well finiſhed and perfectly freſh. From this temple there are flights of ſteps, which ſeem to have led to ſome edifice formerly ſtanding, which Mr. Chambers judges may have been a palace, as water channels are cut out in the rock as drains, and the top of the hill is ſtrewed with pieces of brick. Aſcending the ſlope to the north, is a platform of ſtone 8 or 9 feet long, by 3 or 4 broad, rather elevated, reſembling a couch or bed, with the figure of a lion well executed, at the upper end by way of pillow; the whole cut out of the hill. This the Brahmins of the place called the bed of *Dhermarâjàh*, or *Judiſhter*, mentioned in the Mahabarit, and at a diſtance is a bath executed from the ſolid rock, called the bath of *Dropidy* wife of *Judiſhter*.

Mr. Chambers thinks this couch may rather be called a throne, and a circumſtance which favours this idea is, that a throne in Sanſcrit is called Singhaſen, from *ſing* a lion, and *âſen* a ſeat.

Deſcending round the hill on the oppoſite ſide, you meet ſteps cut from the bottom to a place near the ſummit, where there is an excavation, which ſeems intended for a place of worſhip, with ſculptures of Hindoo deities. The moſt remarkable of which is, Viſhnoo aſleep on a bed, with a huge ſnake wound round to ſerve as a pillow, all in one piece hewn from the ſolid rock.

About a mile to the ſouthward are two pagodas, likewiſe cut out of the ſolid rock. Near them an elephant as big as life, and a lion larger, but well executed. There is great ſymmetry in their form, but in a different ſtyle from the modern pagodas. The latter being Egyptian with pyramidical towers, and the gates and roof flat; but theſe approach nearer to the Gothic taſte. The lions are well ſculptured, but thoſe in modern temples are diſtorted monſters, totally unlike the original.

On one of the pagodas, is an inſcription in a character unknown to the Hindoos, which Mr. Chambers thinks bears ſome affinity to the Balic. Although the outward form of the pagodas is compleat, yet they are not wholly ſo, and a rent of ſome inches breadth, ſeems to have been made throughout the ſolid rock, and appears to extend to the foundation; which Mr. Chambers thinks nothing leſs than an earthquake could have occaſioned.

Between this and the ſea, a Hindoo village ſtood in 1776, but cloſe to the ſea are the remains of a brick pagoda, dedicated to Sib. Near this building are detached rocks, on which appear ſculptures much defaced, and the natives ſay that ſome aged people remembered to have ſeen the tops of pagodas far out at ſea, which being covered with copper (probably gilt,) reflected the ſun's rays. Circumſtances which indicate an inundation, and probably an earthquake. The account given by the Brahmins, natives of the place, although in a fabulous garb is curious, and is as follows:

" Hirinacheren they ſay was a gigantic prince that rolled up the earth into a ſhapeleſs maſs, and carried it to the abyſs, whither Viſhnoo followed, killed him, and replaced the earth in its original ſituation. His brother ſucceeded, but refuſed to do homage to Viſhnoo, and arguing againſt the ſupremacy of Viſhnoo, his ſon Praulhaud aſſerted, that Viſhnoo was every where. *Is he in that pillar?* ſays the father, *then let him come forth*, and ſtriking the pillar, Viſhnoo appeared with the body of a man, but the face of a lion, and tore the father to pieces. Praulhaud was fixed on his father's throne, and his grandſon Namachee, founded the city of Mahabalipoor." The Brahmins alſo ſay " that one of his ſucceſſors, Malecheren, in an excurſion in diſguiſe, met with two celeſtial nymphs, who had come to a garden to bathe. He formed an attachment with one of them, and they both had frequent interviews with him. They introduced a male inhabitant of the heavenly regions, between whom and the rajah a friendſhip enſued, and the former agreed to carry his friend to ſee the court of the divine *Inder*, a favour never before granted to any mortal. On his return with new ideas of grandeur and magnificence, he began to beautify his court and ſeat of government ſo greatly, that an account thereof was carried to all the gods aſſembled at the court of Inder, whoſe jealouſy was ſo much excited, that they ordered the god of the ſea to overflow a place, which pretended to riſe in ſplendor with the celeſtial manſions; the command was obeyed, and the city was overflowed."

Such is the Brahmin account, and which probably may contain records of great events.

Mr. Chambers thinks the inſcription on the pagoda is an object that merits great attention: and the conjecture, that it is one of the languages of Siam is not chimerical, which is ſupported by ſome authors of repute; he alſo thinks that there is ſome affinity between the Balic and Hindoo languages, and that the mode of worſhip which formerly prevailed in the Decan, is now uſed by the Siameſe.

Loubere, in his account of Siam, ſays, the Siameſe aſſert that thoſe who have been on the coaſt of Coromandel, report that language to have a reſemblance to theirs, but the characters they did not underſtand. The Miſſionaries ſay, "that the religion of the Siameſe comes from thoſe parts, and that they had read in a Balic book, that Sommonacodom, idol of the Siameſe, was ſon of a king of Ceylon."

The ſame author ſays, on the authority of the ſame Balic book, that the father of Sommonacodom, was king of Deve Lanca, or Ceylon. Deve Lanca is the Sanſcrit name for Ceylon. *Maha*, ſignifies *great* in both languages.

A pretended print of a foot is to be ſeen in Ceylon, and another in Siam: and the Siameſe ſay, that Somonacodom ſet his right foot on their ground, and his left on Lanca. There is alſo a ſtriking reſemblance in their worſhip, and in other particulars. 1. There is a kind of a tree, (which from deſcription appears to be the Pipel tree) held ſacred by both. 2. Round their temples, are the habitations of the prieſts, who live in them, as in a college. 3. Each people have two orders of prieſts, diſtinguiſhed by yellow habits, and each have the honour of carrying a Tallipot or Tallapat to ſcreen them from the ſun. Tallipot, ſignifies among the Hindoos, the leaf of a Palmyra tree. 4. The prieſts of both are bound to celibacy. 5. They both eat fleſh, but will not kill the animal. 6. Theſe prieſts are of no particular tribe, but choſen out of the people.

Theſe circumſtances ſhew, that their religion is inconſiſtent with the principles and practice of the Brahmins; the only agreement is in the worſhip of the Debtahs. But of the prevailing religion, Loubere ſpeaks very different, and it is certainly very ancient, as from other authorities it will appear, that this worſhip has prevailed in ſeveral parts of India, prior to that of the Brahmins.

In the *Anciennes Relations*, tranſlated by Ranaudot, there is an account of dancing women, which continues to this day in the Decan, but is not known among the Hindoos of Bengal or Hindoſtan Proper.

VI. *Hints relative to friction in Mechanics. By Mr.* Reuben Burrow.

Of friction in the inclined plane.

HAVING given the weight of the body to be ſuſtained; the inclination of the plane and the ratio of the friction to the preſſure; to find the force requiſite to ſuſtain the weight in a given direction.

Let AC be the horizon, AB an inclined plane, draw PR $=$ the given weight perpendicular to AC and PD perpendicular to AB, take PQ to PD as the friction to the preſſure, draw Rm to PQ in the given direction, alſo mt perpendicular to PD ∴ then Rn $=$ the force excluſive of friction, mn $=$ the force neceſſary to overcome the friction, and Rm $=$ the whole moving force, alſo Pt $=$ the preſſure on the plane AB when the whole force is applied, and the locus of the point m will always be in the right line PQ ∴ Fig. 1.

If the body is to be ſuſtained, or ſuſpended only on the plane, the friction will aſſiſt the force, and the point m will fall below n, wherefore it is evident that the motive force is greater than the ſuſtaining force by twice the quantity of friction ∴ Fig. 2.

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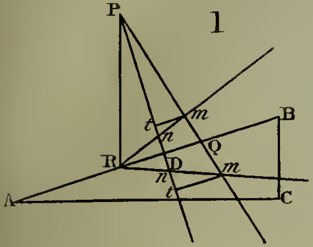

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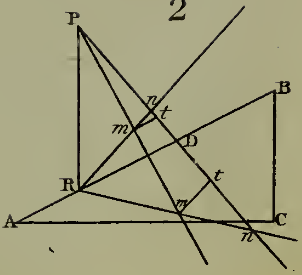

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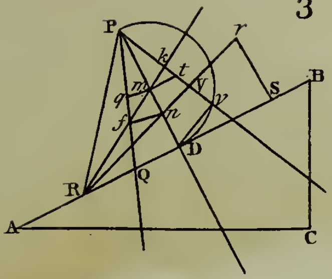

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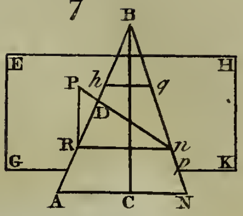

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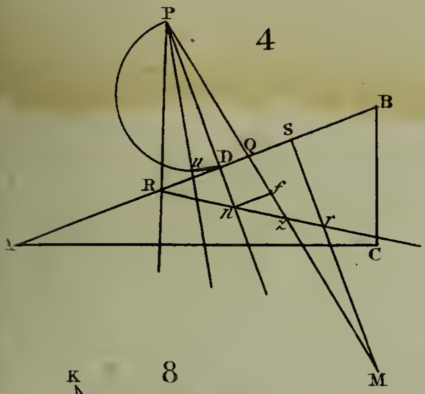

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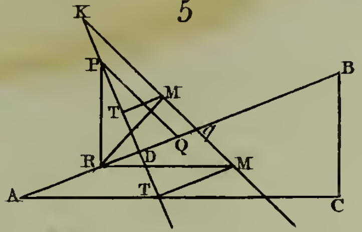

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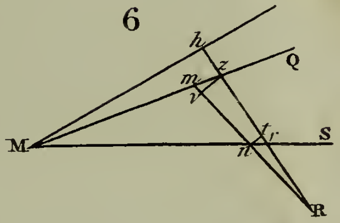

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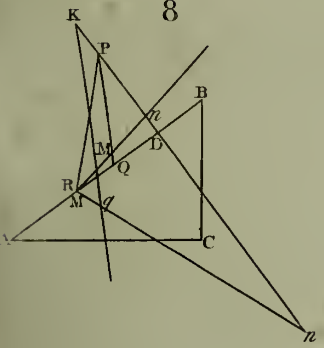

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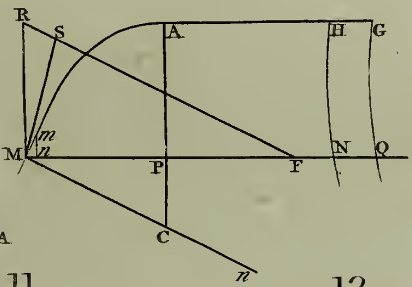

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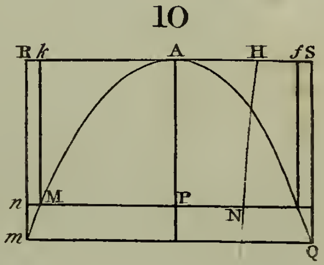

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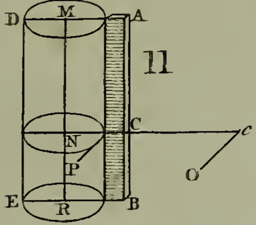

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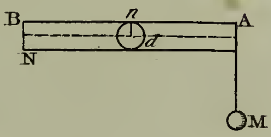

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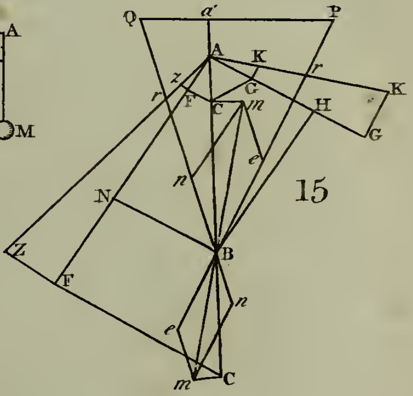

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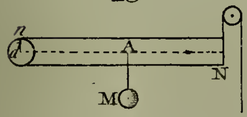

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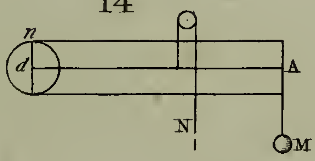

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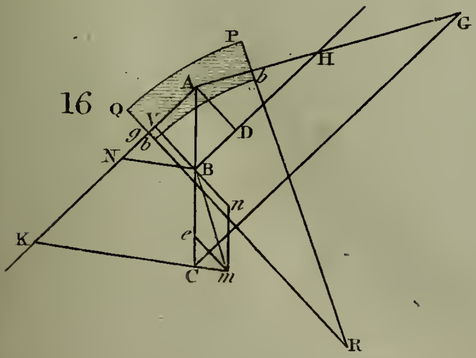

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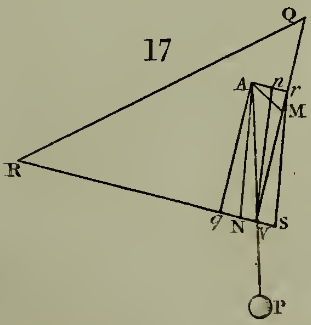

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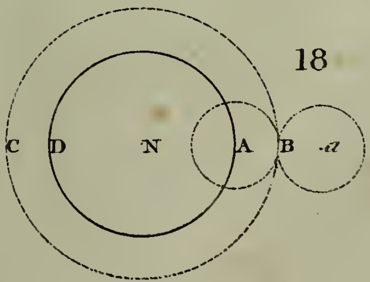

When the direction of the force R*m* is beneath the plane AB, it is evident that this ſolution determines the poſition of land ties, in the conſtruction of walls, wharfs, &c.

Alſo whether the force PM neceſſary to ſuſtain the effect, be a ſuſtaining or a motive force, when it is perpendicular to the direction R*m*, it will be the leaſt poſſible, and conſequently the power will be beſt applied in that poſition. Fig. 1. and 2.

By a ſimilar mode of reaſoning on the hypotheſis, *that the friction in all caſes, is as the preſſure*, Mr. Burrow proceeds to inveſtigate the quantity and effect of friction in four problems, where the directions of the force applied is in different ways, by the ſix following figures in the plate.——On the ſame hypotheſis, he alſo reſolves ſeveral problems reſpecting the *Lever*, the *Pulley*, the *Wedge*, and the *Screw*, but as we preſume, that what has been ſaid of the inclined plane, will be ſufficient to lead the intelligent Geometrician and Mechanic, to Mr. Burrow's mode of reaſoning, we have only inſerted the figures in the order as he has given them, for the reader to contemplate at his pleaſure.

VII. *An account of an interview with Teeſhoo Lama. By Lieut.* SAMUEL TURNER.

DURING his reſidence at *Tibet*, notwithſtanding the emperor of China's orders, that the infant Teeſhoo Lama ſhould be kept in the ſtricteſt privacy, Mr. Turner obtained an interview with him.

The monaſtery erected for the education of Teeſhoo Lama, in which he reſides, has in it a palace encloſed by a wall, occupying a mile in circumference; the ſeveral buildings ſerve to accommodate 300 *Gylongs*, who perform religious ſervices with Teeſhoo Lama, until he is removed to the Muſnud of Teeſhoo Loomboo. Mr. Turner was allowed to viſit him in the morning, and found him placed on his Muſnud, on his left ſtood his father and mother, and on his right his attendants. The Muſnud conſiſts of ſilk cuſhions, elevated four feet from the floor, the top was covered with an embroidered ſilk. The viſitors Mr. Turner and Mr. Saunders were in an Engliſh dreſs. Mr. Turner preſented according to cuſtom, a white pelong handkerchief, and a ſtring of pearls and coral, and having performed the ceremony of exchanging handkerchiefs, he took his ſeat. A multitude who eſcorted Mr. Turner were admitted, and made their proſtrations, the Lama received them with a look of complacency. His father acquainted Mr. Turner that he uſually reſted until this time, but roſe early in expectation of ſeeing the Engliſh gentlemen. The Lama kept his eyes on him, and if their cups of tea which were brought them were empty, ſeemed uneaſy and made a noiſe, for he could not ſpeak, until they were filled. He took a golden cup with confects and ſugar, and made a motion to have it given to Mr. Turner and Mr. Saunders. Mr. Turner was told he ſhould addreſs him, which he did. The child ſeemed attentive, and nodded his head as if he underſtood, and approved of every word, at which his parents ſeemed pleaſed.

This child is about eighteen months old, of a brown complexion, his features good, his countenance expreſſive. A few mornings after, Mr. Turner again waited on him to preſent ſome further preſents, he ſeemed pleaſed with a clock, but did not betray any childiſh emotions.

His votaries began to flock in numbers round him, but few were admitted to his preſence; if they ſee him at a window they are happy. Some Calmuc Tartars came to make their offerings, they were ſtanding at the entrance of the ſquare in front of the palace, each with his cap off, his hands placed together, elevated and held even with his face. In this attitude they remained half an hour, their eyes fixed with anxiety at the Lama's apartment. At length they lifted their hands all together, ſtill cloſed above their heads, then lowered them, dropped on their knees, and ſtruck their heads againſt the ground. They then advanced to deliver their preſent, conſiſting of talents of gold and ſilver, to the proper officers, and retired much ſatisfied. Theſe offerings Mr. Turner found were not unfrequent. No one thinks himſelf degraded by theſe humiliations.

VIII. *Account of a journey to Tibet; in a letter from Lieut.* Samuel Turner *to the Governor General of Bengal.*

THIS journey was performed by *Poorungeer*, the Goſſeyn, who had been employed in deputations to the late Teeſhoo Lama, and had formerly accompanied him to Pekin. This man was ſent with diſpatches from Mr. Haſtings, for Teeſhoo Lama, and the regent of Teeſhoo Loomboo. He departed from Calcutta early in April, through Boutan to Tibet. He was detained at Phari by a fall of ſnow, which was ſo deep as to prevent all travelling. On the 8th of May he reached Teeſhoo Loomboo, the capital of Tibet, and as ſoon as he entered the monaſtery, and announced his arrival to the regent, quarters were allotted to him, and an hour fixed for him to wait on the Teeſhoo Lama, who the next morning removed at dawn of day into tents in his garden. At the time appointed for admiſſion, the young Lama was ranging about his garden, as it was the warmeſt part of the year, an elevated ſeat of cuſhions was placed under a ſhade, where Poorungeer found him accompanied by the regent, his parents, and officers. He approached, making three obeiſances, preſented a piece of pelong, his letters and preſents, which were immediately opened and preſented to the Lama. The Lama opened the letter, and taking from under the cover a ſtring of pearls, laid them by him, and attentively regarding Poorungeer, aſked him if he had had a fatiguing journey. After an hour's audience, during which the Lama ſat very compoſed, Poorungeer took his leave, by bowing his head, and receiving the Lama's bleſſing.

Next morning he viſited the regent, and the Lama's parents, and was cordially received. He found the country in the ſtate he had left it, the only event that had taken place conſiſted in the inauguration of the infant Lama, the preceding year. This inauguration in a political or religious view, is eſteemed a recognizance in an infant form of their regenerated immortal ſovereign and eccleſiaſtical ſupreme.

The emperor of China early in 1784, ſent ambaſſadors to teſtify his zeal, for the religious father of his faith. Dalai Lama, the Viceroy of Laſſa, his court, the heads of every monaſtery in Tibet, and the ambaſſadors, appeared at Teeſhoo Loomboo. A few days previous to the auſpicious day, the Lama was conducted from the monaſtery, in which he had paſſed his infancy, in great pomp, and amidſt ſo vaſt a concourſe of people, that although the journey is but twenty miles, it took up three days. On the laſt day's journey, which was about ſix miles, the road was whitened with a waſh, and piles of ſtones heaped up on each ſide. The retinue paſſed between a double row of prieſts, ſome holding lighted rods of a perfumed compoſition, the reſt with muſical inſtruments, as the gong, cymbal, hautboy, drum, trumpet, and ſea ſhells, which were ſounded in uniſon with the hymn they chanted. The crowd was kept without the high road, which was reſerved for the proceſſion, conſiſting of three military commanders at the head of 6 or 7000 horſemen, armed with quivers, bows, and matchlock, next the ambaſſador, and his ſuit carrying his diploma, made up in the form of a tube, then the Chineſe general with his troops, and a group bearing ſtandards, and inſignia of ſtate, then a band of wind and other inſtruments, two led horſes capariſoned, each carrying ſtoves in which aromatic wood was burned, then a lama bearing a box with books and ſome idols, nine ſumptuary horſes with the Lama's apparel, the prieſts attached to the Lama's perſon, in number about 700, then two men with a cylindrical gold inſignium, emboſſed with emblematical figures, (a preſent from the emperor of China.) Then the Duhunniers and Soopoons, who communicate addreſſes and alms, preceded the Lama on a bier, carried by eight Chineſe, on the one ſide the Lama's father, the regent on the other, the rear was brought up by the heads of the monaſteries, the prieſts who had formed the rows falling into the proceſſion, all moving in a ſlow pace; about noon they were received into the monaſtery, amidſt a diſplay of colours, ſolemn muſic, and chanting.

The Lama being lodged, the Dalai Lama, and regent of Laſſa were conducted with their retinues to the monaſtery. On the third day the Teeſhoo Lama was carried to the great temple and ſeated on the throne, at which time the emperor's ambaſſador delivered his diploma and preſents.

The three next days the Dalai Lama, and Teeſhoo Lama aſſiſted in the worſhip of their Gods, and this compleated the buſineſs of the inauguration. During this time all the capital was entertained at the public expence, alms were diſtributed, and univerſal rejoicings prevailed throughout Tibet. Afterwards preſents and entertainments were given to the Lama, who was not three years of age. Dalai Lama entertained the firſt day, then the Viceroy, the third day the Chineſe general, and the others according to their ranks, each giving and receiving preſents. This laſted forty days. The Dalai Lama and others then returned home.

This traveller alſo related that the commercial intercourſe between Tibet and Bengal, met with no impediment. The regent ſhewed a hearty diſpoſition to encourage this trade, he ſeemed attached to the Engliſh, and ſent letters by Poorungeer to that purport, (which are inſerted in the reſearches) with preſents.

IX. *On the Gods of Greece, Italy, and India.* By Sir WILLIAM JONES.

THE writer begins with obſerving, that though we cannot conclude *a priori* that one idolatrous people muſt have borrowed their deities and worſhip from another; yet that when features of reſemblance too ſtrong to have been accidental, are obſerved in different ſyſtems of polytheiſm, we can ſcarcely help believing that ſome connection has anciently ſubſiſted between the nations adopting them. It is his deſign to point out ſuch a reſemblance between the worſhip of the old Greeks and Italians, and that of the Hindus; nor does he doubt of a great ſimilarity between theſe religions and that of other eaſtern nations, and perhaps ſome ſouthern ones, and even the

American iſlands; while it is at the ſame time certain that the Gothic mythology was the Grecian and Italian only in another dreſs. So that if all theſe reſemblances be proved, a general affinity between the moſt diſtinguiſhed nations of the primitive world may be inferred, at the time that they deviated from the worſhip of the only true God.

There have been four principal ſources of mythology. 1. Hiſtorical or natural truth perverted into fable by ignorance, imagination, flattery, or ſtupidity. 2. A wild admiration of the heavenly bodies, and the ſyſtems and calculations of aſtronomers. 3. The perſonifications of poetry. 4. The metaphors and allegories of moraliſts and metaphyſicians. All theſe cauſes of polytheiſm have operated in filling the catalogue of Grecian divinities, though the authors of ſyſtems have been deſirous of deriving all from ſome one favourite ſource. The writer therefore does not in his enquiries mean to prove that ſuch a God of India was ſuch another of Greece, for we may find many Joves, Apollos, &c. with diſtinct attributes; he only intends to ſhew that in one capacity or other a ſtriking reſemblance prevails between the Gods of the two countries.

He begins with Janus or Gane'sa. The Italian Janus was the God of *Wiſdom*, thence repreſented with *two* or *four faces*; in like manner, the Indian Gane'sa is painted with an *Elephant's* head, the ſymbol of ſagacious diſcernment, and attended by a *Rat*, which the Indians conſider as a wiſe and provident animal. Janus is ſtyled the *father* or *the origin and founder of all things*; he is firſt invoked of all the Gods; the day and year commence from him, and he preſides over great national concerns. The name of Gane'sa is compounded of *iſa*, the *governor* or *leader*, and *gána* or a *company* of deities. Inſtances of opening buſineſs by an ejaculation to him are common. Books are generally begun by *ſalutation to* Ganes. His image is placed on the ground before building a houſe, and is ſet up in temples, ſtreets, and high roads, that he may be invoked before beginning buſineſs, or proceeding on a journey. The preſident adds from his own obſervation, that in a town riſing at *Gaya*, every new built houſe had the name of Gane'sa written on the door.

Concerning Saturn, the Preſident thinks the moſt ſenſible tradition is that ſaid to be mentioned by *Plato*, "that both Saturn or *Time*, and his conſort Cybele, or the *Earth*, together with their attendants, were the children of *Ocean* and *Thetis*, or, in leſs poetical language, ſprang from the waters of the great deep". *Ceres* was their daughter. *Feſtus* derives the Latin name Saturnus, *a ſatu*, from planting, becauſe he introduced agriculture into Italy. On the reverſe of his ancient coins was the ſtern of a ſhip, or galley, for which the reaſon aſſigned by *Ovid*, that he arrived by ſea, is thought very unſatisfactory. An account quoted by *Pomey* from *Alexander Polyhiſtor*, if really ancient, caſts a clearer light on the hiſtory of Saturn; "that he predicted an extraordinary fall of rain, and ordered the conſtruction of a veſſel, in which it was neceſſary to ſecure men, beaſts, birds, and reptiles from a general inundation."

From theſe circumſtances, the Preſident inclines to aſſent to the opinion of *Bochart*, that the fable of Saturn was raiſed on the true hiſtory of *Noah*. The ſame hiſtory in diſguiſe, he thinks, may be found in the ſtory of an Indian king, Menu or Satyavrata, whoſe patronymic name was Vaivaswata, or child of the Sun; and whom the Indians believe to have reigned over the whole world, in the earlieſt age of their chronology, but to have reſided in the country of *Dravira*, on the coaſt of the eaſtern Indian Peninſula. He copies a narrative of the principal event of his life, tranſlated from the *Bhágavat*, which is a ſtrange wild tale, of an allegorical form, containing an account of an univerſal deluge, and the preſervation of a pious man with ſeven others, and pairs of all animals, by means of a veſſel. After commenting on this, the writer goes on to compare the four *Yugs* of the *Hindus*, with the four Grecian and Roman ages, in which he finds a great affinity; beſtowing, however, ſome criticiſm on the regular proportion and extravagant duration of the *Yugs*. He leaves etymologiſts to decide whether the word MENU or MENUS has any connection with the lawgiver MINOS, but points out a ſingular coincidence of character with the *Hindu* God YAMA, who is chiefly diſtinguiſhed as *judge of departed ſouls*. CERES, the poetical daughter of SATURN, is paralleled by the *Goddeſs of Abundance* of the *Hindus*, who is uſully called LACSHMI'. She is, however, not the daughter of MENU, but of BHRIGU, by whom the firſt code of ſacred ordinances was promulgated. One of her names is SRI' or SRI'S, which approaches the Latin *Ceres*, and ſignifies *fortune* or *proſperity*. She is repreſented in ſome very ancient temples with full breaſts, and a cord twiſted under her arm, reſembling a horn of plenty.

JUPITER or DIESPITER as the *Firmament*, is repreſented by the Indian God of the viſible heavens, called INDRA, or the *king*, and DIVESPETIR, or *Lord of the Sky*, who is alſo the chief of good ſpirits. Moſt of his epithets in *Sanſcrit* are thoſe of the *Eunian* JOVE. He is however conſidered as a ſubordinate deity, and far inferior to the Indian Triad, BRAHMA', VISHNU, and MAHA'DEVA or SIVA, who are three forms of one and the ſame Godhead. The reſemblance of ZEUS or JUPITER to this triple divinity is the next topic of the preſident's diſquiſition. The learned Indians acknowledge one ſupreme being, whom they call BRAHME, or the GREAT ONE, in the neuter gender. They ſuppoſe him to operate by his divine ſpirit, whom they name VISHNU, the *Pervader*, and NA'RA'YAN, or MOVING UPON THE WATERS, both in the maſculine gender, whence he is often denominated the *Firſt Male*; by this operation they believe that the whole order of nature is preſerved and ſupported. When they conſider the divine power as exerted in *creating*, they call the deity BRAHMA' in the maſculine gender alſo; and when they regard him as the *Deſtroyer* or *Changer* of forms, they give him a great number of names, of which the moſt common are SIVA, I'SA, or I'SWARA, RUDRA, HARA, SAMBHU, and MAHA'DE'VA, or MAHE'SA. The firſt operations of theſe three powers are deſcribed in a variety of allegories, from which may be deduced the Ionian philoſophy of *primeval water*, the doctrine of the *mundane egg*, and the veneration of the *Nymphæa* or *Lotos*, anciently revered in Egypt, and at preſent in Hindoſtan, Tibet and Nepal.

That water was the primitive element, is the uniform opinion of the Indian Philoſophers; yet it is certain that their ſyſtem did not ariſe from traditions concerning the flood merely, as their doctrine is evidently borrowed in part from the opening of *Geneſis*. A paſſage deſcriptive of the creation, from the beginning of the *Mánava Sáſtra*, is here quoted as a paraphraſe of the three firſt verſes of *Geneſis*; though it alſo contains the notion of the golden egg from whence BRAHMA' was produced.

Which of the Gods was the actor in the creation of the world, is left undetermined by *Ovid*; but it appears from the authority of *Cornutus*, that the old European heathens conſidered JOVE (not the ſon of *Saturn*, but of the *Ether*) as the great *life-giver*, and *father of Gods and men*; and the *Orphean* doctrine, preſerved by *Proclus*, aſſerts that "the abyſs and empyreum, the earth and ſea, the Gods and Goddeſſes, were produced by ZEUS or JUPITER." In this character he correſponds with BRAHMA'. JOVE was likewiſe as the *Helper* and *Supporter* of all. He is alſo repreſented by the poets as the *pervading mind* or *ſoul of the world*; which is preciſely the *Indian* idea of VISHNU.

In this capacity of *Avenger* and *Deſtroyer*, JUPITER, to whom an eagle brought *Lightning* and *Thunderbolts*, overthrew the *Titans* and Giants; in a ſimilar conteſt between SIVA and the children of *Diti*, BRAHMA' is believed to have preſented the God of Deſtruction with *fiery ſhafts*. One of the poems entitled *Rámáyan* contains a dialogue between the crow BHUSHUNDA, and a rational eagle, named GARUDA, who is often painted with the face of a beautiful youth, and the body of a bird. Mr. Sonnerat informs us that VISHNU is in ſome places repreſented as riding on the GARUDA, which he ſuppoſes to be the Pondichery Eagle, a bird much venerated by the Brahmans of the coaſt, but which the Preſident rather conceives to be a fabulous bird. As the *Olympian* JUPITER fixed his court on a lofty mountain, ſo the appropriated ſeat of MAHA'DE'VA was mount *Cailáſa*, a moſt brilliant rock; and his terreſtrial haunts are the ſnowy hills of *Himaláya*. Further, SIVA is believed to have three eyes, whence he is named TRILO'CHAN; and from Pauſanias we learn that *Triophthalmos* was an epithet of ZEUS, and that a ſtatue of him had been found as early as the taking of Troy, with a third eye in his forehead, as he is repreſented by the Hindus.

In the character of *Deſtroyer*, this Indian Deity may be looked upon as correſponding with the *Stygian Jove* or PLUTO, eſpecially as his conſort is CA'LI' or *Time*, who will afterwards appear to be PROSERPINE.

Another attribute of MAHA'DE'VA, by which he is *too* viſibly diſtinguiſhed in the drawings and temples of Bengal, is that of preſiding over *Generation*, as a ſymbol of which he rides on a *white bull*. The loves and feats of JUPITER GENITOR (not forgetting *Europa's white bull*) ſeem to have an evident connection with this part of Indian mythology.

The JUPITER *Marinus*, or NEPTUNE of the Romans, may be reſembled to MAHA'DEVA in his *generative* character; eſpecially as the latter is the huſband of BHAVA'NI', whoſe relation to the waters is evident, from her image being reſtored to them at the concluſion of her great feſtival. She has alſo attributes exactly ſimilar to thoſe of the VENUS *Marina*, who ſprung from the foam of the ſea. It is further remarkable, that the RAMBHA' of INDRA's court, who ſeems to correſpond with the *Goddeſs of Beauty*, was produced from the froth of the churned ocean. The identity of the *triſúla* and the *trident*, the weapon of SIVA and of NEPTUNE, ſeems to eſtabliſh this analogy; and the veneration paid all over India to the large buccinum, eſpecially when its ſpiral line and mouth are turned from left to right, reminds us of the muſic of TRITON.

The way of conſidering the Gods as individual ſubſtances, but as diſtinct perſons in diſtinct characters, is common to the European and Indian ſyſtems, as well as the cuſtom of giving the greateſt number of names to the higheſt. Hence the triple capacity of DIANA, and her petition that ſhe might be *polyonymous*. The conſort of SIVA is eminently marked by theſe diſtinctions; but her leading names and characters are PA'RVATI', DURGA', BHAVA'NI'.

As the *mountain-born* Goddeſs, or Pa′rvati′, ſhe has many properties of the *Olympian* Juno. One of theſe is ſingular, ſhe is uſually attended by her ſon Ca′rtice′ya, who rides on a *peacock*; and in ſome drawings his own robe ſeems ſtudded with eyes. In ſome of her temples a *peacock* ſtands by her without a rider. Ca′rtice′ya, with ſix faces and numerous eyes, may be ſuppoſed to reſemble Argus; yet, being a deity of the ſecond claſs, he ſeems clearly to be the Orus of Egypt, and the Mars of Italy.

In her attributes of Durga′, or *difficult of acceſs*, ſhe reſembles the *armed* Minerva or Pallas; both repreſent *heroic Virtue*; both ſlew demons and giants, and protected their wiſe and virtuous adorers. The *unarmed* Minerva correſponds with Sereswati′, the wife of Brahma′, and the emblem of his principal *creative power*.

Many learned mythologiſts conſider the *peaceful* Minerva as the Isis of Egypt. The Preſident does not doubt that the I′swara and I′si of the Hindus, are the Osiris and Isis of the Egyptians, though a diſtinct treatiſe would be requiſite to prove their identity.

Bhava′ni′ ſeems to be as well the Juno *Cinzia*, or Lucina, as Venus herſelf, not the Idalian queen, but Venus *Urania*, the Goddeſs of *Generation*, on that account ſometimes exhibited of both ſexes, an union common in Indian ſculpture. Both Plato and Cicero ſpeak of Eros, or the heavenly Cupid, as the ſon of Venus and Jupiter; which proves that the monarch of Olympus and the Goddeſs of Fecundity were connected as Maha′de′va′ and Bhava′ni′. One of the moſt remarkable ceremonies in the feſtival of this Indian Goddeſs, is that of caſting her image into the river, of which the *Pandits* know not the reaſon, further than that it is preſcribed by the *Véda*. The Preſident conceives that it has a relation to the doctrine that *water* is a *form* of Iswara, and conſequently of I′sa′ni′, to which her figure is reſtored after having received due honour on *earth*, another *form* of the God of Nature.

Two incarnate deities of the firſt rank, Ra′ma and Crishna are now introduced. The firſt, the writer believes to have been the Dionysius of the Greeks, named alſo Bromius, Bugenes, Lyaios and Triambos, titles adopted and tranſlated by the Romans. He was recorded to have given laws to men, and decided their conteſts, to have improved navigation and commerce, and particularly to have conquered India and other countries with an army of *Satyrs*, commanded by Pan.

Thus Ra′ma, the ſovereign of *Ayódhyà* is believed by the Hindus to have been an appearance on earth of the *preſerving power*, to have been a conqueror of high renown, and the deliverer of nations from tyrants, and to have commanded in chief a numerous race of thoſe large *monkies* which naturaliſts have denominated *Indian Satyrs*. This army of *Satyrs* might have been only a race of mountainers; however, the large breed of apes is at preſent held in high veneration by the Bráhmans, who have regular endowments for their ſupport. Ra′ma's general was the prince of Satyrs, Hanumat, or *with high-cheek-bones*. His father was the God of Wind, named Pavan, one of the eight Genii; and one of the four ſyſtems of Indian muſic bears the name of Hanuma′n, from its inventor.

The ſecond great divinity, Crishna, paſſed a life of a moſt extraordinary nature. He was the ſon of De′vaci′ by Vasude′va; but his birth was concealed through fear of the tyrant Cansa, to whom it had been predicted, that a child born at that time in that family would deſtroy him. He was, therefore, foſtered in *Mat'hurá* by a herdſman, named Ananda, or *Happy*, whoſe amiable wife Yaso′da′ was occupied in her paſtures and dairy. In their family were a number of young *Gópa's*, or *Cowherds*, and beautiful *Gópí's*, or *Milkmaids*, who were his playfellows in his infancy; and in early youth he ſelected *nine* damſels as his favourites, with whom he ſpent his hours in dancing, ſporting, and playing on his flute. For this number *nine*, however, there is no other authority than a picture where nine girls are grouped in the form of an elephant, on which he ſits and pipes; and the word *nava* uſed in a ſtanza deſcribing the God and his paſtime, ſignifies both *nine* and *new* or young. He was a youth of perfect beauty, and continues to this hour the darling God of the Indian women. The ſect of Hindus who adore him with enthuſiaſtic and almoſt excluſive devotion, maintain that Crishna was the *perſon* of Vishnu himſelf in a human form; hence they conſider the third Ra'ma, his elder brother, as the eighth *Avatár*, inveſted with an *emanation* of his divine radiance; and in the principal Sanſcrit dictionary, compiled about 2000 years ago, Crishna, Va'sade'va, Go'vinda, and other names of the ſhepherd God, are intermixed with epithets of Na'ra'yan, or the Divine Spirit. Crishna, when he appears among the *Avatárs*, is more ſplendidly decorated than any of them, and wears a rich garland of ſylvan flowers as low as his ancles. Dark blue, approaching to black (which is the meaning of the word *Criſhna*) is believed to have been his complection; a tint peculiar to Vishnu. He was no leſs heroic in action, than lovely, and when a boy, ſlew the terrible ſerpent *Cáliya*, with a number of giants and monſters; and at a more advanced age, put to death his cruel foe Cansa: and after the concluſion of a war undertaken for the protection of king Yudhisht'hir, he returned to his heavenly ſeat, having left the inſtructions compriſed in the *Gítà* with his friend Arjun, whoſe grandſon became ſovereign of India.

It is impoſſible here not to recognize the features of Apollo, ſurnamed *Nomios* or the *Paſtoral* in Greece, and *Opifer* in Italy, who fed the herds of *Admetus*, ſlew the ſerpent *Python*, and was amorous, beautiful, and warlike. The word *Govinda*, may be literally tranſlated *Nomios*, as *Céſava* is *Crinitus* or *fine haired*. Crishna in Iriſh is aſſerted by Col. Vallancey, to mean the Sun, alſo by the Roman poets is conſidered as the ſame deity with Apollo. But Phoebus, or the *orb of the Sun* perſonified, is adored by the Indians as the God Su'rya. He has a multitude of names, and among the reſt twelve titles, denoting his diſtinct *powers* in each of the twelve months. Theſe powers are called *Adityas*, or ſons of Aditi by Casyapa, the Indian Uranus. Su'rya is ſuppoſed frequently to have deſcended from his car in a human ſhape, and to have left a race on earth renowned in Indian ſtory. Two of his ſons called Aswinau, are conſidered as twin-brothers, and painted like Castor and Pollux, but they have the characters of Æsculapius among the Gods. The Preſident ſuſpects the whole fable of Casyapa and his progeny to be aſtronomical, and cannot but imagine that the Greek name Cassiopeia has a relation to it.

The worſhip of Solar, or Veſtal, *fire* may be aſcribed to the admiration of the powers of nature, and ſeems to be the principal worſhip recommended in the *Védas*. Maha'de'va himſelf is perſonated by *fire*: but ſubordinate to him is the God Agari, often called Pa'vaca, or the *Purifier*, who anſwers to the Vulcan of Egypt; and his wife Swa'ha' reſembles the younger Vesta or Vestia. The *divine artiſt* of the Greeks and Romans, named Vulcan and Hephaistos, ſeems to be the Indian Viswacarman the *forger of arms* for the Gods, and inventor of the *agnyaſtra* or *fiery ſhaft*, in the war between them and the *Daityas*.

A very diſtinguiſhed ſon of BRAHMA', named NA'RED, whoſe actions are the ſubject of a *Purána*, bears a ſtrong reſemblance to HERMES or MERCURY, being a wiſe legiſlator, great in arts and arms, an eloquent meſſenger of the Gods, either to one another, or to mortals, and a muſician of exquiſite ſkill, inventor of the *Víná* or Indian lute.

The laſt of the parallel deities is the *Stygian* or *Taurick* DIANA, otherwiſe named HECATE, and often confounded with PROSERPINE; who is undoubtedly the ſame with CA'LI', the wife of SIVA, in his character of the *Stygian* JOVE. To this black Goddeſs, with a collar of golden ſkulls, *human ſacrifices* were anciently offered, as the *Védas* enjoined, but in the preſent age they are abſolutely forbidden, as are the ſacrifices of bulls and horſes, but kids are ſtill offered to her.

The preſident concludes this paralleliſm of deities with the following remarks. 1. The temporary *Elyſium* in the court of INDRA conſiſts wholly of ſenſual pleaſures, like the paradiſe of Muhammed; but the *Mucti* or *Elyſian* happineſs of the *Védánta* ſchool is far more ſublime, being a total abſorption, though not without conſciouſneſs, in the divine eſſence. 2. In the myſtical and elevated character of PAN, as a perſonification of the *Univerſe*, a ſort of ſimilitude ariſes between him and CRISHN'A conſidered as NA'RA'YAN.

The ſimilarity of the religious ſyſtems of *Greece*, *Italy* and *India* being eſtabliſhed, it will be natural to enquire which was the original, and which the copy; but we do not yet ſeem to have acquired grounds ſufficient for the determination of this point. *Egypt* appears to have been the grand ſource of knowledge for the weſtern, and *India* for the eaſtern parts of the world; but which of the two communicated its mythological ſyſtems to the other can hardly be ſatisfactorily made out. The Preſident here diſcuſſes an opinion ſupported by an Hindu vocabulary of mythological and hiſtorical names, that certain prieſts from *Egypt*, or *Mis'r*, migrated to *India*, and ſettled in *Tirút*. He finds, as might be expected, a good deal of obſcurity attending this inveſtigation; but on the whole he is inclined to believe with *Mr. Schmit* (in his prize diſputation at the Academy of Inſcriptions) that Egyptian prieſts have actually come from the *Nile* to the *Gangà* and *Yamunà*, though perhaps rather to acquire than to impart knowledge. He goes on to remark, that notwithſtanding a connection probably ſubſiſted between the old idolatrous nations of the eaſt and weſt before the time of MOSES, yet that conſidering the abſurd nature of their ſyſtems, there can be no foundation for an opinion that MOSES borrowed the firſt nine or ten chapters of *Geneſis* from them; ſtill leſs that the *Chriſtian* faith has any thing in common with the Indian theology; and he very warmly cenſures a notion propagated by ſome miſſionaries, in order to diſpoſe the Hindus for the reception of Chriſtianity, that the *Indian Triad* of BRAHMA', VISHNU and MAHE'SA is the ſame in reality with the *Chriſtian Trinity*. We ſhall copy the remainder of this Eſſay, as equally curious and important.

"One ſingle fact, however, muſt not be ſuffered to paſs unnoticed. That the name of CHRISHNA, and the general outline of his ſtory, were long anterior to the birth of our Saviour, and probably to the time of Homer, we know very certainly; yet the celebrated poem, entitled *Bàhgavat*, which contains a prolix account of his life, is filled with narratives of a moſt extraordinary kind, but ſtrangely variegated and intermixed with poetical decorations: the incarnate deity of the *Sanſcrit* romance was cradled, as it informs us, among *Herdſmen*, but it adds, that he was educated among them, and paſſed his youth in playing with a party of milkmaids: a tyrant, at the time of his birth, ordered all new-born males to be ſlain, yet this wonderful babe was preſerved by biting the breaſt, inſtead of ſucking the poiſoned nipple, of a nurſe commiſſioned to kill him; he performed amazing, but ridiculous, miracles in his infancy, and, at the age of ſeven years, held up a mountain on the tip of his little finger; he ſaved multitudes partly by his arms and partly by his miraculous powers; he raiſed the dead by deſcending for that purpoſe to the loweſt regions; he was the meekeſt and beſt-tempered of beings, waſhed the feet of the *Bráhmans*, and preached very nobly, indeed, and ſublimely, but always in their favour; he was pure and chaſte in reality, but exhibited an appearance of exceſſive libertiniſm, and had wives or miſtreſſes too numerous to be counted; laſtly, he was benevolent and tender, yet fomented and conducted a terrible war. This motly ſtory muſt induce an opinion that the ſpurious goſpels, which abounded in the firſt age of *Chriſtianity*, had been brought to *India*, and the wildeſt parts of them repeated to the *Hindus*, who ingrafted them on the old fable of CE'SAVA, the APOLLO of *Greece*.

" As to the general extenſion of our pure faith in *Hinduſtan*, there are at preſent many ſad obſtacles to it. The *Muſelmans* are already a ſort of heterodox *Chriſtians*: they are *Chriſtians*, if LOCKE reaſons juſtly, becauſe they firmly believe the immaculate conception, divine character, and miracles of the MESSIAH; but they are heterodox, in denying vehemently his character of Son, and his equality, as God, with the Father, of whoſe unity and attributes they entertain and expreſs the moſt awful ideas; while they conſider our doctrine as perfect blaſphemy, and inſiſt, that our copies of the Scriptures have been corrupted both by *Jews* and *Chriſtians*. It will be inexpreſſibly difficult to undeceive them, and ſcarce poſſible to diminiſh their veneration for MOHAMMED and ALI, who were both very extraordinary men, and the ſecond, a man of unexceptionable morals: the *Korán* ſhines, indeed, with a borrowed light, ſince moſt of its beauties are taken from our Scriptures; but it has great beauties, and the *Muſelmans* will not be convinced that they were borrowed. The *Hindus* on the other hand would readily admit the truth of the Goſpel; but they contend, that it is perfectly conſiſtent with their *Sáſtras*: the deity, they ſay, has appeared innumerable times, in many parts of this world and of all worlds, for the ſalvation of his creatures; and though we adore him in one appearance, and they in others, yet we adore, they ſay, the ſame God, to whom our ſeveral worſhips, though different in form, are equally acceptable, if they be ſincere in ſubſtance. We may aſſure ourſelves, that neither *Muſelmans* nor *Hindus* will ever be converted by any miſſion from the church of *Rome*, or from any other church; and the only human mode, perhaps, of cauſing ſo great a revolution, will be to tranſlate into *Sanſcrit* and *Perſian* ſuch chapters of the Prophets, particularly of ISAIAH, as are indiſputably evangelical, together with one of the Goſpels, and a plain prefatory diſcourſe containing full evidence of the very diſtant ages, in which the predictions themſelves, and the hiſtory of the divine perſon predicted, were ſeverally made public; and then quietly to diſperſe the work among the well-educated natives; with whom if in due time it failed of producing very ſalutary fruit by its natural influence, we could only lament more than ever the ſtrength of prejudice and the weakneſs of unaſſiſted reaſon."

X. *A deſcription of a cave near Gyá.* *By* JOHN HERBERT HARRINGTON, *Eſq.*

THE hill or rock, from whence this cavern is dug, lies fourteen miles north of Gyá, and ſeems to be one of the hills called by Rennel *Caramſhàh*: it is now called Nagurjenee. Its texture is of granite. The cave, ſituated on the ſouthern declivity, has only one entrance from the ſouth, 2 feet 6 inches broad, 6 feet high, and of equal thickneſs. This leads to a room of an oval form with a vaulted roof, 44 feet long from E. to W. 18 feet 6 inches broad, and 10 feet 3 inches high in the center, dug out of the rock, and well poliſhed. The ſtone is altogether 100 feet in length. The chief of a neighbouring village, ſaid there is a tradition, that a celebrated Mahomedan, who lived in the ſixth century of the Hegira, performed his *Cheelah* or forty days devotion in it. This room is now frequented by Mahomedans. There are two inſcriptions, one on each ſide of the interior part of the entrance, which Mr. Harrington's *Moonſhee* took off, and one of which Mr. Wilkins has been able to explain. There are ſeveral other caves in the adjoining hills with inſcriptions. Theſe caves Mr. Harrington thinks, were religious temples. A letter from Mr. Wilkins to the ſecretary of the ſociety, is inſerted reſpecting this inſcription. He ſays the character is the moſt ancient of any that has come under his knowledge, diſſimilar from that now uſed, and alſo from that uſed 1800 years ago. The language is pure Sanſcrit, written in a long verſe, and conſiſting of four pauſes of nineteen ſyllables each. The firſt line of the firſt verſe, alludes to the ſtory of Bhewanees killing the evil ſpirit Maheeſhaſoor, who, in the diſguiſe of a buffalo, as the name imports, had fought with Eendra and his celeſtial bands for ſix hundred years, defeated him, and uſurped the throne. The ſtory is to be found at large in a little book called *Chandee.* Mr. Wilkins laments the want of a date.

XI. *Tranſlation of a Sanſcrit inſcription found on a ſtone at Bood-dha-Gaya, by Mr.* WILMOT, 1785.—*Tranſlated by* CHARLES WILKINS, *Eſq.*

THIS inſcription tells us that Bood-dha, the author of happineſs, the poſſeſſor of all, appeared at the beginning of the Kalee Yoog: he who is omnipreſent and everlaſtingly to be contemplated, the ſupreme being, the eternal one, the divinity worthy to be adored by the moſt praiſe worthy of mankind, appeared here with a portion of his divine nature. That *Amara,* renowned among men, endeavoured to render the god Bood-dha propitious, remained in the foreſt twelve years, feeding on roots and fruits, performed the vow of a *Moonee,* and was without tranſgreſſion. He had a viſion which told him, that *the ſame reward may be obtained from the ſight of an image, as from the immediate viſitation of a Deity.* Hearing this, he cauſed an image of the ſupreme ſpirit Bood-dha to be made, and worſhipped it according to the law.

XII. *Account of the college of the Seeks* at Patna.* *By* CHARLES WILKINS, *Eſq.*

ON entering the gate, Mr. Wilkins was accoſted by two of the ſociety, who told him, that was a place of worſhip open to all men, but he muſt pull off his ſhoes, with which he complied, and was then politely conducted into the hall and ſeated on a carpet in the midſt of a numerous aſſembly. The whole building was about forty feet ſquare, raiſed about ſix or eight ſteps from the ground. The hall is in the center divided from four apartments, by wooden arches upon pillars of the ſame materials, all neatly carved. On the floor was a carpet with ſix or ſeven deſks, on each a book of the law; the walls hung with looking glaſſes in gilt frames, pictures of Muſſelman princes, and Hindoo deities. On the left hand was a room as a chancel, with an altar covered with cloth of gold, on which lay a round black ſhield, a broad ſword and a *choultry* of peacocks feathers. The altar was raiſed a little above the ground, before it ſtood a ſmall throne, and about it were ſeveral ſilver flower pots, and roſe water bottles, and three urns to receive charitable contributions, there is a deſk, and a book, from whence ſome portions were daily read.

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* A ſect diſtinguiſhed from the worſhipers of Brahm' and the followers of Mahommed.

At noon notice was given that it was the hour for divine ſervice. The deſk and book were removed to the other ſide of the hall, and an old man with a ſilver beard kneeled down with his face to the altar, having on one ſide of him a man with a ſmall drum, and two or three cymbals. The old man chaunted to the tune of the drum and cymbals, and at the concluſion of the verſe the audience joined in chorus with marks of joy. The time was quick, they ſung a hymn in praiſe of the unity, omnipreſence and omnipotence of the deity. On the concluſion, the congregation aroſe and turned their faces towards the altar. A young man then ſtood up and pronounced a long prayer, a kind of liturgy; at the end of certain periods, the people exclaimed *wa gooroo*. This prayer was followed by a ſhort bleſſing from the old man, and an invitation to the aſſembly to partake of a friendly feaſt. The people being ſeated, a large iron chauldron juſt taken from the fire, was placed on a ſtool, ſome diſhes of ſilver and a pile of leaves ſewed together as plates were brought in. One plate was given to each perſon, the diſhes were filled from the chauldron, and the contents ſerved to every one, (our author was not forgotten). It was a kind of ſweetmeat, compoſed of flour and ſugar mixed with clarified butter. The ſugar plumbs were ſerved, which ended the ceremony, and which Mr. Wilkins was told is repeated five times a day.

Mr. Wilkins learned that the founder of this faith was Naneeck Sah, who flouriſhed about four hundred years ago at Punjab, and who before his apoſtacy was a Hindoo of the military tribe, and whoſe body diſappeared as the Hindoos and Muſſulmans were diſputing for it. He left behind him a book, teaching the doctrines of his faith, written in a character partly of his own invention, which character they call *Gooroo Morkee: from the mouth of the preceptor*. This book, of which that at the altar was a copy, teaches that there is but one God, omnipotent and omnipreſent, that there will be a day of retribution; it commands toleration, and forbids diſputes with thoſe of a different perſuaſion; it forbids murder, theft, &c. and inculcates the practice of virtue, particularly a univerſal philanthropy and general hoſpitality to ſtrangers.

Some years after this book, another made its appearance, Mr. Wilkins was offered copies of both. The word *Seek* was borrowed from one of the commandments of their founder, ſignifying *to learn*, and was adopted as ſoon as he diſappeared. A perſon deſiring to become a proſelyte, and declaring ſo to four or ſix Seeks aſſembled together, they procure a ſmall quantity of a certain ſweetmeat, diluted with water, and ſprinkle ſome on his body and eyes, while one of them repeats to him in a language the proſelyte is acquainted with, the chief canons of their faith, exacting from him a promiſe to abide by them. This is the whole ceremony. He then chooſes a *Gooroo* or preceptor, who teaches him the language of their ſcriptures, beginning with the alphabet. They offered to admit Mr. Wilkins, but he declined, and took only a copy of their alphabet, which differs but little from the Dewnagur. The language is a mixture of Perſian, Arabic and Sanſcrit, grafted on the provincial dialect of the Punjab, which is a dialect of the Hindoos; vulgarly called by us *Moors*.

XIII. *Account of a muſical inſtrument called the Been, or Vina. See Plate* I. *Fig.* 3.

THE Been is a fretted inſtrument of the guittar kind. The finger board is $21\frac{6}{8}$ths inches long. A little beyond each end of the finger board are two large gourds, and beyond theſe are the pegs and tail piece which hold the wires. The whole length of the inſtrument is three feet ſeven inches. The firſt gourd is fixed at ten inches from the top, and the ſecond at about two feet $11\frac{1}{2}$. The gourds are very large, about fourteen inches diameter, and have a round piece cut out of the bottom about five inches in diameter. The finger board is about two inches wide. The wires are ſeven in number, and conſiſt of two ſteel ones very cloſe together in the right ſide, four braſs ones on the finger board, and one braſs one on the left ſide.

The great ſingularity of this inſtrument is the height of the frets; that neareſt the nut is one inch$\frac{1}{8}$, and that at the other extremity about $\frac{7}{8}$ths of an inch, and the decreaſe is pretty gradual. By this means the finger never touches the finger board itſelf. The frets are fixed on with wax by the performer himſelf, which he does intirely by ear. The frets are nineteen in number.

The Been is held over the left ſhoulder, the upper gourd reſting on that ſhoulder, and the lower one on the right knee.

The frets are ſtopped with the left hand, the firſt and ſecond fingers are principally uſed. The third finger is ſeldom uſed, the hand ſhifting up and down the finger board with great rapidity. The fingers of the right hand are uſed to ſtrike the ſtrings of this hand, the third finger is never uſed. The two firſt fingers ſtrike the wires on the finger board, and the little finger ſtrikes the two wires. The two firſt fingers of this hand are defended by a piece of wire put on the tops of them in the manner of a thimble, when the performer plays ſtrong, this cauſes a very jarring diſagreeable ſound, whereas when he plays ſoftly the tone of the inſtrument is remarkably pleaſing.

XIV. *A deſcription of the Máhwah tree. By Lieut.* CHARLES HAMILTON.

THIS tree, by the natives of Bahar and the neighbouring countries, is called *Máhwar* or *Mawee*; but the Sanſcrit name is *Madhúca* or *Madhudruma*. It is of the claſs and order *Polygamia monogynia* of Linnæus, but of a new genus.—See Plate I. Fig. 4, *a b c d*.

The *calyx* is monophyllous, quadrifid, half divided, and imbricated.

The *corolla*, monopetalous, conſiſting of an inflated tubular part, terminating in nine ſmall foliated diviſions, imbricated and twiſted, and claſping the ſtyle in a point. It is near an inch long, thick, fleſhy, and cream coloured.

Filaments none: *antheræ* 26, long, lanceolate, inſerted in rows on the inſide and upper part of the tube of the corolla.

Style, long, round, tapering, projecting about an inch beyond the corolla. Succeeded by a *drupe* with a thick pericarp, bilocular, ſometimes trilocular, with one ſeed in each cell, being a kernel covered with a dark brown ſkin.

The flowers grow in bunches, from the extremities of the ſmaller branches, upon pedicles an inch and half long.

The tree is middle-ſized, buſhy, with oval pointed leaves. A reſinous gum exudes from the bark on inciſion.

One of the moſt remarkable circumſtances relative to this tree, is, that its flowers, which have rather the appearance of berries, fall off in great numbers as they come to maturity, and when dried, reſemble in taſte and flavour a dried grape. They are collected by the natives, and eaten raw, or in curries, and afford a ſtrengthening and wholeſome nutriment. They alſo yield by diſtillation a ſtrong ſpirit. They make an article of trade, being exported in conſiderable quantities. The fruit reſembles a ſmall walnut. The ſeeds are replete with a thick oil, procured by expreſſion, of the conſiſtence of butter or *ghee*, and uſed for ſimilar purpoſes. It is alſo an article of exportation. The wood is tough and ſtrong, and fit for various uſes.

The *Máhwah* tree will grow in almoſt any ſoil, even the moſt barren. It is found abundantly in its full-grown ſtate, but none are to be met with in an infant ſtate; for notwithſtanding its utility, ſuch are the indolence and depreſſion of the poor natives, that they never think of planting it. Mr. Hamilton greatly recommends a proper attention to the raiſing of it, ſuggeſting ſome directions for the purpoſe, and giving a calculation of its profits. It might, he ſuppoſes, be made an effectual reſource againſt the dreadful famines which often rage in thoſe countries.

XV. *Of the method of Diſtilling as practiſed by the natives at Chatra in Ramgur, and in the other provinces, perhaps, with but little variation.* By Archibald Keir, *Eſq.*

THE body of the ſimple ſtill, uſed by theſe people, is a large, unglazed, earthen water jar, nearly of a globular form, with a ſhort neck. This is ſunk into a furnace dug in the ground, ſo contrived, that the flame circulates round about one third of it. To this body is luted an *adkur*, conſiſting of two earthen pans perforated in the middle with holes four inches diameter, and joined by their bottoms. The lower of theſe ſerves as the cover to the body; and the upper, which has a groove within its neck, as the inferior part of the head. A hole in the groove admits a tube communicating with a receiver. The ſuperior part of the head is made by a copper pot, inverted upon the upper pan of the *adkur*, and going within it, leaving a brim all round. When theſe pieces are well luted together with clay, a water pot is ſet at the back part of the furnace, ſomewhat higher than the head of the ſtill, having a perforation, and a tube going from it, ſo as to throw a conſtant ſtream of water upon the center of the copper pot forming the head. This ſpreads over the ſurface of the pot, and then falls into the projecting part of the *adkur*, where a hole is made to convey it away through a trough to a reſervoir. The water pot when empty is repleniſhed from the reſervoir. By this apparatus, the vapour ariſing from the body of the ſtill, is condenſed faſt enough in the head to run off in a ſtream, with very little loſs; and Mr. Keir thinks, that much more ſpirit was drawn off, than from one of our ſtills of twice the dimenſions with its worm and cooler, in the ſame time. This advantage he attributes to the ſudden condenſation taking place in the head, the thin metal of which quickly imparts its heat to the ſurrounding ſtream of water; while the thickneſs of the earthen *adkur*, keeps the ſpirit flowing along the groove as cool as poſſible.

The ſuperiority of ſpirits made by European diſtillers, to thoſe procured by the natives with the ſimple apparatus above deſcribed, Mr. Keir attributes, not to the mode of conducting the diſtillation, which he rather thinks is in favour of the latter; but to longer keeping of the ſpirits before they are uſed. And he adds ſome remarks to ſhew, that the noxious quality of raw ſpirits, is owing to the looſe and more uncombined ſtate in which their inflammable principle is united to their aqueous part.

He concludes with ſuggeſting, that from the principles of diſtillation as above laid down, ſome uſeful hints might probably be derived in the proceſſes for extracting the volatile parts of the finer aromatics.

XVI. *A method of calculating the Moon's Parallaxes, in Latitude and Longitude.*—

By Mr. REUBEN BURROW.

MR. Burrow obſerves, that among the problems publiſhed by authority of the Board of Longitude, there is one for calculating the place of the Nonageſimal degree, which Mr. Burrow thinks erroneous, and recommends the following

PROBLEM.

Given the apparent time at any given place; to find the longitude and altitude of the Nonageſimal degree, and alſo the parallaxes in latitude and longitude.

1. Turn the difference of longitude from Greenwich into time, and add it to the apparent time, if the place be to the weſt of Greenwich; but ſubtract if the place be to the eaſt, and the ſum, or remainder, will be the apparent time at Greenwich.

2. To this time calculate the ſun's right aſcenſion in time, and add it to the apparent time at the given place; the ſum is the right aſcenſion of the meridian in time.

3. From the latitude of the place by obſervation ſubtract the correction taken from page 75 of Mayer's Tables; the remainder is the latitude in the ſpheroid.

4. Call the right aſcenſion of the meridian in degrees AR; and if the right aſcenſion of the meridian

$$\text{Be between}\left\{\begin{array}{l}0^\circ\text{ and }90^\circ\\90\text{ and }270\\270\text{ and }360\end{array}\right\}\begin{array}{l}\text{then in}\\\text{North}\\\text{Latitude,}\end{array}\left\{\begin{array}{l}AR+90\\270-AR\\AR-270\end{array}\right\}\begin{array}{l}\text{is an}\\\text{Arc A.}\end{array}\left\{\begin{array}{l}\text{but in}\\\text{South}\\\text{Latitude,}\end{array}\right\}\begin{array}{l}90^\circ-AR\\AR-90\\450-AR\end{array}\left\{\begin{array}{l}\text{is the}\\\text{Arc A.}\end{array}\right.$$

5. Let half the ſum of the colatitude of the place and the obliquity of the ecliptic be called C; and half their difference D; then add the ſecant of C, the coſine of D, and the cotangent of half A, together; the ſum (rejecting twice radius) is the tangent of an arc M; then add the coſecant of C, the ſine of D, and the cotangent of half A, together; the ſum (rejectiug twice radius) is the tangent of an arc N: then if the colatitude of the place be greater than the obliquity of the ecliptic, the ſum of M and N is an angle, whoſe complement call B; but, if the colatitude be leſs than the obliquity, let the complement of the difference of M and N be called B.

6. Add the ſecant of B, the ſine of A, and the coſine of the latitude of the place, together; the ſum (rejecting twice radius) is the ſine of the altitude of the nonageſimal degree.

7. Add the tangent of the latitude to the tangent of the obliquity of the ecliptic; the ſum is the ſine of an angle, which call X.

8. When the right aſcenſion of the Meridian is

$$\text{Between}\left\{\begin{array}{c}360^\circ-X\text{ and }90\\ 90\text{ and }180+X\\ 180+X\text{ and }270\\ 270\text{ and }360-X\end{array}\right\}\begin{array}{l}\text{in}\\ \text{N.}\\ \text{Lat.}\end{array}\left\{\text{or between}\right\}\left\{\begin{array}{c}X\text{ and }90\\ 90\text{ and }180-X\\ 180-X\text{ and }270\\ 270\text{ and }X\end{array}\right\}\begin{array}{l}\text{in}\\ \text{S.}\\ \text{Lat.}\end{array}\text{then}\left\{\begin{array}{c}B\\ 180-B\\ 180+B\\ 360-B\end{array}\right\}\text{is the Longitude}$$

of the nonageſimal degree.

9. Add the moon's latitude to 90° when it is of a contrary name to the latitude of the place; but ſubtract it from 90° when it is of the ſame name; the ſum or remainder, is the moon's polar diſtance: alſo take the difference between the moon's longitude and the longitude of the nonageſimal degree; which difference call P: alſo let half the ſum of the moon's polar diſtance and altitude of the nonageſimal degree, be called Q; and half their difference, R.

10. Add the ſecant of Q, the coſine of R, and the cotangent of half P, together; the ſum is the tangent of an arc *m*; alſo add the coſecant of Q, the ſine of R, and the cotangent of half P together; the ſum is the tangent of an arc *n*.

11. If the altitude of the nonageſimal degree be greater than the moon's polar diſtance, take the ſum of the arcs *m* and *n* for the parallactic angle; but if it be leſs, take their difference.

12. Add the coſecant of the parallactic angle, the ſine of P, and the ſine of the altitude of the nonageſimal degree, together; the ſum (rejecting twice radius) is the ſine of the moon's true zenith diſtance.

13. To the ſine of the moon's true zenith diſtance add the logarithm of the horizontal parallax; the ſum (rejecting radius) is the logarithm of the parallax in altitude nearly; add the parallax, thus found, to the true zenith diſtance, and the ſum will be the corrected zenith diſtance.

14. Add the ſine of the corrected zenith diſtance, the coſine of the parallactic angle, and the logarithm of the horizontal parallax, together; the ſum (rejecting twice radius) is the logarithm of the parallax in latitude.

15. Add the logarithm of the parallax in latitude, the tangent of the parallactic angle, and the ſecant of the moon's latitude, together; the ſum (rejecting twice radius) is the logarithm of the parallax in longitude.

EXAMPLE.

"What is the altitude and longitude of the nonageſimal degree at Ludlow whoſe lat. is 52° 23′ north, and longitude 0h. 11 m. weſt of Greenwich, 7th February 1778, at 10h. 56. 11 app. time, being the time of an occultation of Geminorum."

Not having the almanack for 1778, I ſhall aſſume the moon's latitude to be 0° 51′S. and her longitude 91°. 57′

10h.	56′	11″	Ap. time
0	11	0	diff. Long.
11	7	11	Ap. t. Greenwich

52°	23′	Latitude,
0	14	Correction.
52	9	Reduced Lat.
37	51	colat.
18	55	half colat.
11	44	half obliq.

21h.	27′	14″	☉AR
10	56	11	
8	23	25	AR of Meridian.
		15	
125°.	51	15	=AR
270			
144	8	45	=A

Sec. C 30°39′ + Coſ. D 7°11′ + Cot. $\frac{1}{2}$ A 72°4′ = Tang. M 20°28′ } 25° + 90° = B 115°
Coſec. C 30 39 + Sine D 7 11 + Cot. $\frac{1}{2}$ A 72 4 = Tang. N 4 32 } Longitude
Sine A 144 9 + Coſ. Lat. 52°9′ + Sec. B 115° = Sine 58°15′ Altitude. Nonogeſ.
Tang. Lat. 52°23′ + Tang. obliq. 23°28′ = Sine 34°18′ = X
45°26′ = half ☽'s polar diſt.
29 8 = half alt. Nonogeſimal degree

Sec. Q 74 34 + Coſ. R 16°18′ + Cot. $\frac{1}{2}$ P 11°32′ = Tang. m 86°46′ } m—n = 31°48
Coſec. Q 74 34 + Sine R 16 18 + Cot. $\frac{1}{2}$ P 11 32 = Tang. n 54 58 }
Coſec. m—n 31°48′ + Sine 58°15′ + Sine P 23°3′ = Sine 39°11′ ☽'s true Zen. diſt.
Sine 39°11′ + Log. Hor. Pax. 3488 = Log. 2204 Pax. in alt. nearly.
Sine Cor. Zen. diſt. 39.47.44 + Log. HP. 3488 + Coſ. 31°48′ = Log. Pax. in Lat. 1898.
Log. 1898 + Tang. 31°48′ + Sec. ☽'s Lat. 0°51′ = Log. Pax. in Long. 1177.

When the moon is very near the ecliptic as in eclipſes, the following method will be nearly exact.

1. Add the coſine of the altitude of the nonageſimal degree to the logarithm of the horizontal parallax; the ſum (rejecting radius) is the logarithm of the parallax of latitude nearly; add this parallax to the complement of the altitude of the nonageſimal degree and call the ſum the complement of the altitude of the nonageſimal degree corrected.

2. Add the coſecant of the complement of the altitude of the nonageſimal degree; the ſine of the complement of the altitude of the nonageſimal degree corrected, and the logarithm of the parallax of latitude nearly, together; the ſum (rejecting twice radius) is the logarithm of the parallax in latitude corrected.

3. Add the logarithm of the parallax in latitude corrected; the ſine of P, and the tangent of the altitude of the nonageſimal degree, together; the ſum (rejecting twice radius) is the logarithm of the parallax in longitude.

Scholium. The method of applying the parallaxes uſually given requires no other correction than the following. When the pole of the ecliptic of the ſame name as the latitude is under the horizon, to the cotangent of the altitude of the nonageſimal degree add the cotangent of the moon's latitude; the ſum is the coſine of an angle; which added to, and ſubtracted from, the longitude of nonageſimal degree gives two longitudes, between which the moon's latitude of a contrary name to the elevated pole is to be increaſed for the apparent latitude; but beyond thoſe longitudes the moon's true latitude is to be increaſed by the parallax in latitude to have the apparent latitude.

Remarks on the Artificial Horizons, &c. By Mr. Reuben Burrow.

THE utility of a perfect horizon and the liableneſs of quickſilver to be diſturbed by the leaſt wind, have induced numbers of people to invent artificial horizons of different kinds, and many of them very complicated. Some time ago having occaſion to determine the ſituation of ſeveral places by aſtronomical obſervations and there being no aſtronomical quadrant belonging to the company in the ſettlement, I was under a neceſſity of determining the latitudes by a ſextant; and that at a time when the ſun paſſed ſo near the zenith as to make it impoſſible to get meridian altitudes: I therefore collected all the different artificial horizons and glaſs roofs and other contrivances for that purpoſe I could meet with; but, though they appear correct, the reſults were very erroneous. I examined them by bringing the two limbs of the ſun, ſeen by direct viſion, to touch apparently in the teleſcope of a ſextant, and then obſerved the reflected images in quickſilver, which ſtill appeared to touch as before; but, on examining the reflected images in the reſt of the artificial horizons, none of them appeared to touch; and the error in many was very conſiderable. I tried a number of other methods with little ſucceſs; as they were, moſtly, combinations of glaſſes: at laſt, accidently hearing ſome officers ſpeaking of "tents that would neither turn ſun nor rain," I conſidered that the rays of the ſun would paſs through cloth unrefracted; and in conſequence of this idea I applied ſome thin moſquita* curtain as a covering to the quickſilver, and found it effectually excluded the wind and admitted the ſun; and what is of equal conſequence in this country, it totally kept away thoſe minute inſects that diſturb the ſurface of the quickſilver in obſerving; in ſhort it formed ſo complete a horizon that I could not before have hoped for any thing ſo perfect; and it is equally applicable to the ſun and ſtars.

For taking very great or very ſmall elevations of the ſun (which with the common horizon ſextants are impracticable in the direct method), a poliſhed metalline inſtrument might be made in the form of part of a hollow obtuſe cone: this might have its axis ſet perpendicular to the horizon at any time *by means of ſcrews* in a variety of methods; and obſervations might be made by it with great exactneſs.

In finding the latitude, when meridian obſervations cannot be taken, either there is an opportunity of taking altitudes on both ſides of the meridian, or not: when there is not, the beſt method is to calculate the latitude from two altitudes and the time between, exactly by ſpherical trigonometry (firſt correcting the declination to the beginning and end of each interval) as the approximating methods of Dowes and others are totally inſufficient: when obſervations can be taken both before and after noon it is beſt to take a number of altitudes in both, and then make out the equal altitudes by proportion; then having found the true time of noon by the uſual method, correct the two intervals and the declination to each time, and the latitude may be found as follows.

Coſ. horary angle + Cot. decl. = Cot. A ∴ Sine A + Sine Alt. + Co. Ar. Sine decl. = Coſ. B A ± B = Lat. required.

As every ſingle altitude gives an independent latitude, it is evident the latitude may be thus found to great exactneſs.

An inſtrument might eaſily be contrived to meaſure the ſun's angle of poſition to great exactneſs, from whence the latitude might readily be deduced; a ſmall addition to the common theodolite would be ſufficient. The variation of the azimuth near the meridian may alſo be advantageouſly applied for the ſame purpoſe.

Demon-

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* A kind of ſilk gauze as cloſe as book-muſlin, and perfectly tranſparent: it is to be ſtretched over a hoop which ſtands without touching the veſſel containing the mercury.

Demonſtration of a Theorem concerning the Interſections of Curves. By REUBEN BURROW *Eſq.*

IN Stone's mathematical dictionary is the following paragraph: "two geometrical lines of any order will cut one another in as many points as the number expreſſes which is produced by the multiplication of the two numbers expreſſing thoſe orders:" and Mr. Braikonbridge in the preface to his *Exercitatio Geometrica de deſcriptione Curvarum,* ſays: "Mr. George Campbell, now clerk of the ſtores at Woolwich, has got a neat demonſtration of the ſame which he hopes he will publiſh." As it does not appear that Campbell ever publiſhed any thing except a paper on the roots of equations, and a ſmall treatiſe on the plagiariſms of MACLAURIN, is is very probable his demonſtrations is loſt, and therefore it may not be improper to publiſh the following.

The equation of a line of the firſt order has one root, or function of the abſciſs, for the ordinate; of the ſecond order, two; and ſo on.

In equations for two right lines the roots may ſo vary and accommodate themſelves to each other, that the quantities expreſſing the ordinates may be equal; and as there is only one caſe where this can happen, therefore two right lines can only interſect in one point.

If a line of the firſt order be compared with a line of the ſecond; or an equation of one root with an equation of two; the root of the firſt and a ſingle root of the ſecond may ſo vary as to become equal to each other, or to form an interſection; by the ſame reaſon, the ſingle root of the firſt, and the remaining root of the ſecond may each ſo vary as to become equal, or to form another interſection, and therefore a right line cuts a line of the ſecond order in two points.

If a line of the firſt order be compared with a line of the n order, it is alſo evident that the ſingle root of the firſt line, may in the ſame manner be ſo varied with each of the n roots of the ſecond line as to become equal; and therefore a right line may cut a line of the n order in n points.

Let a line of the m order be now compared with a line of the order n; then as each ſingle root of the firſt line may become equal, in the ſame manner, to every root in the ſecond; it therefore follows that for every unit in m there may be n interſections, and as there are m units, there conſequently will be mn interſections.

The ſame method may be applied to the determination of the points, line, and ſurfaces, that ariſe from the interſections of lines, ſurfaces, and ſolids; by conſidering that the number of times that p may be taken from m, and q at the ſame time from n, will be

$$= \frac{m.\overline{m-1}\ldots\ldots p,}{1.2.3\ldots\ldots p,} \times \frac{n.\overline{n-1}\ldots q}{1.2.3\ldots q}$$

XVII. *The Proceſs of making Attar, or Eſſential Oil of Roſes. By Lieut. Colonel* POLIER.

THIS celebrated eſſence is obtained from roſes by a ſimple diſtillation, conducted in the following mode. A quantity of freſh roſes (forty pounds; for inſtance) with their calyxes, but with their ſtems cut ſhort, are put into a ſtill with ſixty pounds of water. The maſs is well mixed with the hands, and a gentle fire is made under the ſtill. When fumes begin to ariſe, the cap is put on, and the pipe fixed; the chinks are luted; cold water is put into the refrigeratory, and the receiver adapted. A moderate fire is continued; but when the water begins to come over, it is gradually leſſened. The diſtillation is carried on till thirty pounds of water are drawn off, which generally happens in about four or five hours. This roſe water is poured upon forty pounds more of roſes, and from fifteen to twenty pounds are drawn off by the ſame proceſs as before. This cohobated roſe water is poured into pans of earthen ware or tinned metal, and left expoſed to the freſh air for a night; when the *attar* or eſſence will be found in the morning congealed and ſwimming on the ſurface of the water: it is to be carefully ſkimmed off, and poured into a vial. When a certain quantity has been thus obtained, the water and feces are to be ſeparated from the clear eſſence. The firſt is eaſily done, as the eſſence congeals with a ſlight cold, when the water may be poured from it. The feces may then be made to ſubſide, by keeping the eſſence fluid by heat. They are as highly perfumed as the eſſence. The roſe water, after all the eſſence has been ſkimmed from it, is to be employed in future operations inſtead of common water.

The very ſmall quantity of eſſence obtainable from the roſes in India has cauſed various additions to be made in the diſtillation, particularly ſandal wood; but this adulteration is diſcoverable by the flavour of the ſandal, and the fluidity of the oil in common cold. In Caſhemire a ſweet-ſcented graſs is uſed as an addition, which does not injure the perfume, but impedes its congelation. The proportion of pure eſſence yielded by the roſes is very variable, from differences in the ſeaſons, and in the manner of conducting the proceſs. In India, three drachms from one hundred pounds of leaves is a large proportion. Mr. Polier, from a large field of roſes, procured only at the rate of two drachms to the hundred pounds. The colour of the *attar* is no criterion of its quality. He obtained it green, yellow, and reddiſh, from roſes of the ſame ground, but collected on different days. The calyxes do not impair the quality of the *attar*, nor give it a green colour.

By Mr. MACDONALD, *with a Specimen of Gold.*

THIS gold was the production of the country of *Limong*, in the iſland of *Sumatra*, contiguous to the preſidency of *Fort Marlborough*. It is of a whitiſh colour, very pure, found near the ſurface ſometimes in duſt, and ſometimes in a hard ſtone, whence it is diſengaged by the natives by beating the maſs, ſo that the ſtone flies off in ſplinters. Mr. Macdonald ſuppoſes that the inland country of Limong may be as rich in gold as either Peru or Mexico. Various difficulties have as yet prevented its being explored; but he thinks that the exertions to overcome them would be well repaid. A native has given a rude chart of a chain of gold-mines, extending nearly three degrees of latitude, to Mr. Miller of Fort Marlborough. Mr. Macdonald ſupports the conjecture that Sumatra was the *Ophir* of *Solomon*.

XVIII. *On the Literature of the Hindus, from the Sanſcrit, communicated by* GOVERDHAN CAUL, *with a ſhort commentary.*

THE TEXT.

THERE are eighteen *Vidya's*, or parts of true knowledge, and ſome branches of knowledge falſely ſo called.

The firſt four are the *Véda's*, evidently revealed by God. The firſt of theſe, *Rigveda*,

Rigveda, conſiſts of five ſections; the ſecond, *Yajurvéda*, of 86; the third, *Sámavéda*, of 1000; fourth, *At'harvavéda*, of nine, with 1100 branches. The chief part of them is that, which explains the duties of man; and in the fourth is a ſyſtem of divine ordinances.

From theſe are deduced the four *Upavêdas*. *Ayuſh*, which comprizes the theory of diſorders and medicines. *Gandharva*, of muſic. *Dhanuſh*, of arms and implements of war. *St'hapatya*, of 64 mechanical arts.

Six *Anga's*, or bodies of learning, are alſo derived from the ſame ſource. The firſt on pronunciation; the ſecond on religious ceremonies; the third on grammar; the fourth on trials of charms and incantations; the fifth of aſtronomy; and the ſixth of difficult words and phraſes in the *Véda's*.

Laſtly, four *Upánga's*. Firſt, *Purana*, compoſed by Brahma, &c. for the inſtruction of mankind; ſecondly, *Nyáya*, teaching the difference between right and wrong, and the principles of knowledge; thirdly, *Mímanſá*, on moral law and religious duties.

The body of law, called *Smriti*, conſiſts of eighteen books on the duties of religion, juſtice. and expiation for crimes.

The *Véda's*, contain all that relates to the duties of kings; the *Purana's*, what belongs to the relation of huſband and wife; and the duties of friendſhip and ſociety are taught diſtinctly in both. The *Bhárata* and *Ramayana*, both epic poems, comprize the moſt valuable part of ancient hiſtory. For the information of the lower claſs in religious knowledge, are the *Paſúpata* and the *Pancharatra*, &c.

What follows are not really divine. *Sanc'hya*, in two parts, containing an enumeration of natural bodies and their principles.

The *Mímauſá*, in two parts; the *Nyaya*, in two; the *Sanc'hya*, in two; and theſe ſix ſchools contain all the doctrines of the Theiſts.

Laſtly, a work written by Buddha. There are alſo ſix Atheiſtical ſyſtems of philoſophy, which omit what ought to be expreſſed, and expreſs what ought to be omitted.

Such is the analyſis of univerſal knowledge, practical and ſpeculative.

COMMENTARY.

The firſt chapter of a Sanſcrit book, called *Vidyaverſa*, or a view of learning, is in ſome parts obſcure. From the beginning we learn that the *Véda's* are conſidered by the Hindus as the fountain of all knowledge.

The *Véda's* conſiſt of three *Can'das*, or general heads, *works, faith, and worſhip*; to the firſt of which the author of the *Vidyaderſa* wiſely gives the preference. The triple diviſion of the *Véda's* may ſeem to throw light on a very obſcure line in the *Gítá*, "*The Véda's are attended with three qualities, be not thou a man of three qualities*, O Arjuna." But ſeveral Pandits think the phraſe muſt relate to the three qualities of the mind, *excellence, paſſion, and darkneſs.*

It is ſingular, that although Brahma's *four* mouths are each ſaid to have uttered a *Véda*, yet ancient writers mention only three, whence it is inferred that the *At'harvan* was written after the three firſt. The following arguments will confirm this opinion: In the eleventh book of Menu, it is ſtyled the *Véda* of *Véda's*; and Dara Shecu'h aſſerts, that it is a corollorary of them all. But this verſe of Menu's is omitted in the beſt copies, and we believe is an interpolation.

Col. Polier poſſeſſes a complete copy of our *Véda's*, by which it appears, that even a learner of Sanſcrit may read the *At'harvaveda* without a dictionary, but the ſtyle of the other three is obſolete. It would not be eaſy to give a genuine extract from the other *Véda's*; a ſtanza from the *Yajurveda* is introduced in a book entitled *Sevavedanta*, which for its ſublimity deſerves to be quoted.

There the ſun ſhines not, nor the moon and ſtars; there lightnings flaſh not in that place; *how ſhould even fire blaze* there? *God irradiates all this bright ſubſtance; and by its effulgence the univerſe is enlightened.*

After all, the *Véda's*, or what is *known*, and the *Sruti*, or what is *heard*, are ſuppoſed to be numerous, and the *four* to have been ſelected, as containing all the information neceſſary for man. Among the commentaries on the Hindu ſcriptures, which are innumerable, that of Vaſiſhtha is the moſt excellent.

From the *Véda's* are deduced the practical arts of *Chirurgery*, *Medicine*, *Muſic*, and *Dancing*; *Archery*, which comprizes the whole art of war, and *Architecture*, including the mechanical arts. Each of the four *Véda's* are ſaid to have produced an *Upaveda*, but this ſeems a refinement.

Infinite advantage may be derived to Europeans from the medical books in Sanſcrit. Many books in proſe and verſe have been written on muſic, with ſpecimens of Hindu airs, in an elegant notation.

Next to theſe are the ſix *Vedanga's*, three of which belong to grammar, one to religious ceremonies, one to mathematics, and one to the explanation of obſcure words, &c. in the *Véda's*. The grammatical work of Pánini is very abſtruſe. Aſtronomical works in this language are exceedingly numerous.

Subordinate to theſe are the ſeries of ſacred poems, the body of laws, and ſix philoſophical *Saſtra's*, which the author of the text reduces to two.

The ſyſtem of Hindu laws conſiſts of many tracts in high eſtimation, as the *Menuſmriti*, &c. Among thoſe current at Bengal, are an excellent treatiſe of *Inheritances*, and a compleat digeſt, in 27 volumes, which is the grand repoſitory.

Of the philoſophical ſchools, it will be ſufficient to remark, that the firſt *Nyara* ſeems analogous to the Peripatetick, the ſecond the Ionick, the *Mimanſas* to the Platonick, the firſt *Sanc'hya* to the Italick, the ſecond to the Stoick. The original works of thoſe firſt philoſophers are very ſuccinct, but there are commentaries on them without end.

It reſults from this analyſis, that the *Véda*, *Upavéda*, *Vedanga*, *Purana*, *Dherma*, and *Derſana*, are the ſix great *Saſtra's*, or ſacred ordinances, in which all knowledge human and divine, is ſuppoſed to be comprehended.

The *Súdra*, or fourth claſs of Hindus, are not permitted to ſtudy the ſix *Saſtra's* above mentioned, but they have an ample field in a multitude of books which correſpond with thoſe *Saſtra's*, and abound with beauties of every kind. The beſt lexicon or vocabulary was compoſed by Amaraſiha; the beſt grammar by Vopadeva. To the *Coſha's*, or dictionaries, are annexed etymological commentaries.

Of the heterodox writings, thoſe on the religion of Buddha ſeem connected with the moſt curious parts of Aſiatick literature.

XIX. *An Indian grant of land in Y. C.* 1018, *literally tranſlated from the Sanſcrit, as explained by* Ramalochan Pandit; *communicated by General* CARNAC.

GENERAL CARNAC ſays, this inſtrument, which conſiſts of ſix ancient copper plates faſtened together by a ring, in two parcels, each containing three, was found in digging for ſome new works at the fort of Tanna, the capital of Salſet. None of the Gujerat Bramins could explain the inſcription.

After a ſtrange bombaſt introduction, a grant is made from the king of Tagara, who governs the whole country of Concana, of the village of *Chavinara*, with certain rights.

Remarks on the City of Tagara. By Lieut. FRANCIS WILFORD.

THE Greeks becoming acquainted with India, by the expedition of Alexander and Ptolemy, Philadelphus having ſent one Dyonyſius into the ſouthern parts, to enquire into the nature of that country. Tagara began to be known to that people about 2050 years ago. Arrian in his Periplus, ſays it was a large city, and produced many manufactures; all kinds of merchandize throughout the Decan were brought to Tagara, and carried from thence in carts to Baroach. Arrian alſo informs us, that Tagara was ten days journey eaſtward of Phithana and Pluthana, and twenty days journey ſouth of Baroach, through the Balagaut mountains. Here Mr. Wilford obſerves, that the Latin tranſlation of the Periplus by Stuckius, is inaccurate: that *anodiai peyiſai* is the true tranſlation of the Hindoo word Bala-gaut, and this paſſage fixes the time when theſe mountains was firſt heard of in Europe.

Pluthana is an important point, as it regulates the ſituation of Tagara; it ſtill exiſts, goes nearly by the ſame name, being called *Puetanah*, and is ſituated on the Godavery, 217 miles ſouth of Baroach, the twenty days journey giving nearly 11 miles or five coſs a day, the uſual rate of travelling with carts. The onyx and other ſtones mentioned by Arrian, are found there.

Arrian ſays, Tagara was ten days journey eaſt of Pultana, that is about 100 miles, and conſequently Tagara falls at Deoghir, now called Doulat-abad.

Ptolemy agrees with Arrian, if we admit he has miſtaken Paithana for Plithana, an eaſy miſtake in the Greek. Paithana, now Patan, is about half way between Tagara and Phithana. Ptolemy ſays, Tagara and Patan are north of the Baund-Ganga or Godavery, which is right. Buſſy in his marches, places Patan by miſtake ſouth of the Godavery.

In Arrian's Periplus, it appears that when the Greeks arrived in the Decan, Tagara was the metropolis of a large diſtrict called Ariaca, comprehending the greater part of the Subah of Aurangabad, and the ſouthern part of Concan, and the northern part of that diſtrict, including Damaun, Salſet, Bombay, &c.

Arrian lived about the 160th year of the preſent æra, but his materials were far more ancient. He ſays, the Greeks were prohibited from landing at Callian, conſequently this paſſage has reference to a time, previous to the conqueſt of Egypt by the Romans.

About the middle of the firſt century, Tagara was no longer the capital of Ariaca, Rajah Salbahan having removed the ſeat of empire to Patan. This Salbahan ſeems to be the ſame as mentioned by Ptolemy, under the name of Siropolemœus, &c.

Salbahan being ſlain by ſome revolted rajahs, Tagara again became the metropolis of Ariaca, and was ſo towards the end of the eleventh century, as appears from the above grant of land.

When the Muſſelmans invaded the Decan, Tagara or Deoghir was the diſtrict of a powerful rajah, and remained ſo until the time of Shah-Jehan, when it became a Subah to the Mogul. Then Tagara was deſerted, and Kirkhi, four coſs S. E. now Aurungabad, became the capital; after the rajahſhip had continued above 2000 years.

It may appear ſtrange, that although the rajah of Tagara was poſſeſſed of a tract of ſea coaſt, yet all trade was carried on by land; it was not ſo formerly, goods were brought to Callian near Bombay, and others ſhipped off, until the Greeks offended the rajah, and were no longer allowed to trade. There were other harbours on the coaſt of Callian, belonging to the ſame rajah, but they were not frequented on account of pirates.

XX. *On the Pangolin of Bahar.*

THE animal here deſcribed, differs from the *Pangolin* of Buffon, in the following particulars. "It has hardly any neck; and, though ſome filaments are diſcernible between the ſcales, they can ſcarcely be called briſtles. But the principal difference is in the tail; that of Buffon's animal being long, and tapering almoſt to a point; while that of ours is much ſhorter, ends obtuſely, and reſembles in form and flexibility that of a lobſter." The natives of Bahar call it *Bajar-cít*, or, as they explain it, *Stone-vermin*. This animal had a tea cup full of ſmall ſtones in his ſtomach; but the writer rather thinks that the name alludes to the hardneſs of its ſcales. The dimenſions of this animal are much leſs than thoſe aſſigned in general by Buffon to the Pangolin, being only thirty-four inches from the ſnout to the end of the tail; the tail, fourteen of theſe. If, therefore, the ſpecies be the ſame, this muſt have been a young ſpecimen. See Plate I. Fig. 5.

XXI. *Inſcription on the Staff of Firuz Shah.*

ON a ſingular monument near Delhi, which the natives call the Staff of Firuz Shah, are ſeveral old inſcriptions, partly in ancient Nagari characters, and partly in an unknown character. Five are intelligible.

The firſt is on the S. W. of the pillar, detached from the reſt, about ſeventeen feet from the baſe; this is a date of the year 1250.

Second conſiſts of ſome ſtanzas, imperfect.

Third and fourth, alſo imperfect.

Fifth, an elegy on the death of a king named Vigraha.

XXII. *A converſation with* Abram, *an Abyſſinian, concerning the City of Gwender and the ſources of the Nile. By the* PRESIDENT.

GWENDER, according to Abram, is the metropolis of Abyſſinia, and lies between two broad and deep rivers, which both flow into the Nile, at the diſtance of fifteen days journey; the walls are of red ſtone, and the roofs of thatch; the palace

lace has a plaiſtered roof, and ſtands in the midſt of the city; the markets are plentiful, and the inhabitants are fond of milk, cheeſe and whey, but the country people make no ſcruple of drinking the blood and eating the raw fleſh of an ox, cut off either dead or alive, but this is by no means common. Grapes and peaches ripen there; wine is in abundance, but mead is the common inebriating liquor. The royal forces are conſiderable; the troops are armed with muſkets, lances, bows, arrows, and hangers. The council of ſtate forms the executive government.

Abram went in the ſervice of a *Vazir* to ſee the fountains of the Nile or Abey, about eight days journey from Gwender: he ſaw three ſprings, one of which riſes from the ground with great noiſe. The Preſident ſhewed Abram the deſcription of the Nile by Gregory, of Amhara, printed by Ludolf, and he ſaid it was conformable to all he had ſeen or read in Ethiopia. He ſaid ſix or ſeven languages were ſpoken there, but the moſt elegant was the Amharic. That beſides their ſacred books, they had hiſtories of Abyſſinia, and other literary compoſitions, and that their language was taught in ſchools. He ſaid all the Abyſſinians admitted the exiſtence of a royal priſon, in which the ſons and daughters of kings are confined. All theſe he ſuppoſed could be explained in the writings of Yákúb, whom he ſaw thirteen years ago in Gwender, who was a phyſician, and had been to the ſource of the Nile. The Preſident had no doubt but this Yákúb was Mr. James Bruce, the celebrated traveller.

XXIII. *On the trial by Ordeal, among the Hindus, by* Ali Ibrahim Khan, *chief magiſtrate at Banares. Communicated by* WARREN HASTINGS, *Eſq.*

THE word *Divya*, in Sanſcrit, ſignifies an oath, or the form of invoking the Supreme Being, to atteſt the truth of an allegation, but it is generally underſtood to mean the trial by *ordeal*, which may be conducted nine ways.

1. By *balance*. The beam and ſcales being adjuſted, the accuſed perſon and a Pandit faſt a day; then the accuſed having bathed, the *oblation* being preſented to fire, and the deities worſhipped, he is carefully weighed; when taken out of the ſcale, the Pandits pronounce an incantation, and having written the ſubſtance of the accuſation on paper, bind it on the head of the accuſed. Six minutes after he his weighed again, and if he weighs more, he is held guilty; if leſs, innocent; if the ſame weight, he is weighed again. If the balance break, it is a proof of guilty.

2. For the *fire-ordeal*, an excavation is made and filled with *pippal* wood, into this the perſon walks barefooted, and if burned is held guilty.

3. *Water ordeal*; the perſon is to ſtand in a depth of water to reach his navel; a Bramin then enters the water holding a ſtaff in his hand; a ſoldier ſhoots three arrows on the ground, and a man is ſent to bring the fartheſt arrow, after he has taken it up another runs from the edge of the water, at which time the accuſed is to graſp the ſtaff of the Bramin and dive under water, and if he riſes before the two men return with the arrow he is deemed guilty. Near Benares, the perſon muſt dive under the water until a man has walked fifty paces gently.

4. There are two ſorts of trial by *poiſon*. Firſt, the accuſed muſt eat from the hand of a Bramin ſeven barley corns of *viſhanaga*, a poiſonous root, or white arſenic mixed in clarified butter; if the poiſon has no effect he is abſolved, otherwiſe condemned.

Second, the hooded ſnake, called *naga*, is thrown into a deep pot, which the perſon accuſed is to take out with his hand: if the ſerpent bite him, he is pronounced guilty.

5. By *coſha*, the accuſed is made to drink three draughts of water, in which the images of the *Sun*, and other deities have been waſhed; if within fourteen days he has any indiſpoſition, the guilt is conſidered as proved.

6. By *rice*, when ſeveral perſons are ſuſpected of theft, ſome rice is weighed, with a ſacred ſtone, called *ſalgram*; the ſuſpected perſon is ordered to chew a quantity of it, they are then to throw it out on ſome leaves of *pippal*, or the bark of a tree, called *nepal*, or *caſhmir*. The man from whoſe mouth the rice comes dry, or ſtained with blood, is deemed guilty, the reſt innocent.

7. By *hot oil*, this is very ſimple. The perſon, when it is ſufficiently heated, thruſts his hand in, and if it does not burn him he is deemed guiltleſs.

8. By *hot iron*. In the ſame manner they make an iron ball, or head of a lance, red hot, and if it does not burn him he is judged guiltleſs.

9. By *images*. An image called *Dharma*, or the genius of juſtice, is made of ſilver, and another called *Adharma*, of iron or clay; they are put into a large jar, and the accuſed thruſts his hand in, if he brings out the ſilver image he is acquitted, if the other, he is guilty; or theſe figures are ſometimes painted on cloth and rolled in cow dung.

The four principal caſts have each its ordeal. The Brahman muſt be tried by the balance; a Cſhatriya by fire; Vaiſya by water; and a Sudra by poiſon; but ſome have decided that any ordeal, except by poiſon, may be performed by a Brahman: and that a man of any caſt may be tried by the balance: a woman may have any trial except by poiſon and water.

Certain months and days are limited for the different ſpecies of ordeal in the Mitacſhera, which preſcribes alſo other deſtinations.

An inſpired legiſlator, Cátyayana, was of opinion, that though a theft or fraud could be proved by witneſſes, yet the party might be tried by ordeal; that if a 1000 panas are ſtolen, the proper trial is by poiſon: if 750, by fire, and ſo on.

A trial by red hot balls, is thus deſcribed in the commentary on Yagyawelcya. At day break the place is waſhed; at ſun riſe the Pandits pay their adoration to Ganeſa, draw circles with cow dung, and worſhip the deities twice, in the mode preſcribed by the ſaſtra. The perſon to be tried performs an oblation, puts on moiſt cloaths, and turning to the eaſt, ſtands in the firſt circle. After ſome ceremonies, a hot ball is put into his hands, then he is to ſtep from circle to circle; and when he has reached the eighth he is to throw the ball into the ninth. If he eſcapes unhurt he is conſidered as innocent.

In 1783, a man was tried by the hot ball at Benares, in the preſence of Ali Ibrahim Khan. A man accuſed another of larceny, and the evidence not being ſufficient, trial by fire ordeal was offered and accepted; and although this mode was not conformable to the company's government, inſiſted on, and at laſt allowed.

The Pandits having worſhipped the god of knowledge, formed the nine circles, and after the accuſtomed ceremonies, and having put into his hands ſeven leaves of pippal, ſome flowers, and moiſtened barley, delivered to the accuſed the hot ball, which he carried and threw into the ninth circle, his hands unhurt. The event amazed all, and our relater ſuggeſts that the moiſt leaves were the cauſe of his not being injured.

Our author gives the particular ceremonies attending the trial by hot oil, in which the accuſed was burned, and ordered to make an atonement, but as amercements are not uſual at Benares, the mulct was remitted, and the priſoner diſcharged.

The record of this conviction was ſent to Calcutta, and the governor-general put many queſtions about the meaning of Sanſcrit words, and the caſes here reported; and received for anſwer, That *homa* meant oblations to the Deity, and that theſe *homa* were different, and adapted to different occaſions; that the *pippala* leaves were ſpread about and not heaped up in the hand of the accuſed; that the man who performed the fire ordeal was not much agitated, and the perſon tried by hot oil perſiſted in denying his guilt.

This piece concludes with the Indian law of ordeal, verbally tranſlated, the ſubſtance of which is given above.

XXIV. *On the Literature of Aſia. Being the ſecond Anniverſary Diſcourſe delivered to the Society, February* 24, 1785. *By the* PRESIDENT.

IN this diſſertation, the Preſident does no more than point out general objects of enquiry to the ſociety, in their attempts to acquire a knowledge of the arts, ſciences, and literature of India. He begins with touching upon the importance of ſtudying the natural hiſtory of the country, under the heads of botany and chemiſtry. He then mentions the painting, architecture, muſic, poetry, and oratory of the eaſt, particularizing ſome of their moſt eſteemed works; and proceeds to the ſciences properly ſo called, mathematics, and juriſprudence. He recommends it to the members, to give a ſhort deſcription of ſuch manuſcripts as each may have peruſed, with a liſt of ſuch queſtions as had occurred to him on the occaſion; and ſuggeſts the advantages that may be expected from the aid of the learned natives in their enquiries.

XXV. *On the Hindu's. Being the third Anniverſary Diſcourſe delivered to the Society, February* 2, 1786.

AFTER a few obſervations on the defects of *Mr. Bryant's* very learned *Analyſis of Ancient Mythology*, drawn from the uncertainty of etymological proofs, and the adoption of a ſynthetical inſtead of an analytical mode of reaſoning, the Preſident proceeds to enumerate the five nations who have in different ages divided *Aſia* among themſelves, viz. the *Indians*, the *Chineſe*, the *Tartars*, the *Arabs*, and the *Perſians*. He begins with the firſt, chiefly as being the region then inhabited by the ſociety; and ſtates the term of his enquiries into the hiſtory of India to be from the earlieſt records down to the Mahommedan conqueſts, at the beginning of the eleventh century.

INDIA, in its large ſenſe, comprehends a ſpace almoſt as extenſive as Europe, being divided on the weſt from *Perſia* by the *Arachoſian* mountains, bounded on the eaſt by the *Chineſe* part of the further peninſula, on the north by the wilds of *Tartary*, on the ſouth ſtretching as far as the iſles of *Java*. In all this extent of country, the primitive religion and languages of the *Hindus* prevail with more or leſs purity, and the *Nágarì* letters are uſed with more or leſs deviation.

The *Hindus* believe their own country to have been the portion of *Bharat*, one of the nine brothers, whoſe father had dominion over the whole earth. This domain of *Bharat* they conſider as the middle of the *Jambudwípa*, a remarkable appellation; for *Jambu* is the *Sanſcrit* name of a delicate fruit called *Jáman* by the *Muſelmans*, and by us, *roſe-apple*; but the largeſt and richeſt ſort is named *Amrita*, or *Immortal*; and the mythologiſts of *Tibet* apply the ſame word to a tree bearing *ambroſial fruit*, adjoining to *four* vaſt rocks, from which as many ſacred rivers derive their ſtreams.

The inhabitants of this extenſive tract have, both in ancient and modern times, been diſtinguiſhed as differing in their figure and manners from all the contiguous nations. But ſince their civil hiſtory beyond the nineteenth century is involved in fables, we poſſeſs only four general media of ſatisfying our curioſity concerning it. Theſe are, their *Languages* and *Letters*; their *Philoſophy* and *Religion*; the remains of their *Sculpture* and *Architecture*; and the written memorials of their *Sciences* and *Arts*.

1. The Mahommedans found the people of *Hinduſtan proper* ſpeaking a language, the pureſt dialects of which were current in the diſtricts round Agra, which is commonly called the idiom of *Vraja*. Five words in ſix, perhaps, of this were derived from the *Sanſcrit*, in which books of religion and ſcience were compoſed. But the baſis of the *Hinduſtání*, particularly the inflexions and regimen of verbs, differed widely from both thoſe tongues. From conſidering the general effect of conqueſt upon languages, the Preſident is of opinion, that the pure *Hindu* was primeval in upper *India*, into which the *Sanſcrit* was introduced by conquerors from other kingdoms in ſome very remote age. The *Sanſcrit* is of a wonderful ſtructure; more perfect than the *Greek*, more copious than the *Latin*, and more exquiſitely refined than either, yet bearing to each a ſtronger affinity both in the roots of verbs, and in the forms of grammar, than could have been produced by accident; ſo ſtrong indeed, that no philoſopher could examine them all three, without believing them to have ſprung from ſome common ſource. There is a ſimilar reaſon for ſuppoſing the *Gothic*, *Celtic*, and old *Perſian*, to have had the ſame origin.

The *characters* in which the languages of India were originally written, are called *Nágarì*, from *Nagar* a city, with *Déva* ſometimes prefixed, as having proceeded from the Divinity himſelf. With a little variation in form, they are ſtill adopted by more than twenty kingdoms and ſtates; and the Preſident believes the ſquare *Chaldaic* letters to have been originally the ſame, as well as the *Phœnician*, from which the *Greek* and *Roman* alphabets were formed.

2. Of the *Indian* Religion and Philoſophy the Preſident thinks it ſufficient to ſay, that they are now living among the adorers of thoſe very Deities who were worſhipped under different names in old Greece and Italy; and among the profeſſors of thoſe philoſophical tenets which the *Ionic* and *Attic* writers illuſtrated with all the beauties of their language. The *Scythian* and *Hyperborean* doctrines may alſo be traced in every part of theſe regions, nor can it be doubted that WOD or ODIN was the ſame with BUDDHA, whoſe rites were probably imported into India nearly at the ſame time that the other were into Scandinavia, though received much later by the *Chineſe*, who ſoften his name into Fo.

He finds this a proper place for fixing an important era in the Hindu Chronology; for the prieſts of BUDDHA left in Tibet and China the preciſe epoch of his appearance in this empire. On taking a medium of the different accounts of this epoch given by writers, the time of BUDDHA, or the *ninth* great incarnation of VISHNU, may be reckoned the year 1014 before Chriſt. The *Caſhmirians* aſſert that he appeared about two centuries before Crishna, which gives another important era. And as the *three firſt Avatàrs* or deſcents of Vishnu relate to an *univerſal deluge*, and the *fourth* and *fifth* to the *puniſhment of impiety* and the *humiliation of the proud*, we may aſſume that the *ſecond*, or *ſilver*, age of the Hindus was ſubſequent to the diſperſion from *Babel*; ſo that we have only a dark period of about a thouſand years for the ſettlement of nations, and the foundation of the forms of civil ſociety. The great incarnate Gods of this intermediate age are both named Rama, but with different epithets. One is a deſcendant from Su'rya, or the Sun, as the huſband of Si'ta'; and it is very remarkable that the *Peruvians*, whoſe Incas boaſted of the ſame origin, ſtyled their greateſt feſtival *Ramaſitoa*; whence we may ſuppoſe that *South America* was peopled by the ſame race who imported the rites and hiſtory of Rama into the fartheſt parts of Aſia.

3. With reſpect to the remains of *architecture* and *ſculpture*, the Preſident briefly obſerves, that they ſeem to prove an early connection between India and Africa. The vaſtneſs and mythological ſtyle of both are reſembling; and the letters on many of the Indian monuments appear to be partly of Indian, and partly of Abyſſinian or Ethiopic origin.

4. Of the *arts* and *ſciences* of India, we know that the labours of the loom and needle there have been univerſally celebrated, for which alſo the people of Colchis and of Egypt were anciently famous. Silk was alſo fabricated immemorially by the Indians; and there are many reaſons to believe that the Hindus were in early ages a commercial people. They were alſo eminent in moral wiſdom; and the fables of Vishnuserman, which we call *Pilpay's*, were firſt tranſlated from the *Sanſcrit*, and are extant under various names in more than twenty languages. The Hindus are ſaid to have boaſted of three inventions, the method of inſtructing by *apologues*, the *decimal ſcale*, and the game of *cheſs*. They have numerous works extant on grammar, logic, rhetoric, and muſic; many poems of various ſpecies; and their *Vedas* abound with metaphyſical ſpeculations, and fine diſcourſes on the being and attributes of God. They have an ancient medical book, entitled *Chereca*, believed to be the work of Siva; for each of the divinities in their *Triad* has at leaſt one ſacred compoſition aſcribed to him. A philoſopher named Yavan Acha'rya (becauſe, we are told, he had travelled into *Ionia*) is ſaid to have given a ſyſtem of the univerſe founded on the principle of *attraction*, and the *central* poſition of the ſun.

The reſult of theſe curſory obſervations is, that the *Hindus* had an immemorial affinity with the old *Perſians*, *Ethiopians*, and *Egyptians*, the *Phenicians*, *Greeks*, and *Tuſcans*, the *Scythians* or *Goths*, and *Celts*, the *Chineſe*, *Japaneſe*, and *Peruvians*; and as no reaſon appears for believing that they were a colony from any one of thoſe nations, or thoſe from them, it may be concluded that they all proceeded from ſome *central* country, to inveſtigate which will be the object of the Preſident's future diſcourſes.

XXVI. *Cor-*

XXVI. *Correctiońs of the Lunar Method of finding the Longitude.* By *Mr.* Reuben Burrow.

THE intent of the following remarks is to point out errors in the uſual practice of making the lunar obſervations, and in the method of computation.

It is well known that a little before and after the conjunction, the whole hemiſphere of the moon is viſible, and the enlightened creſcent ſeems to extend ſome diſtance beyond the duſky part. Now, having determined the longitude of a place from the eclipſes of Jupiter's ſatellites, I took ſeveral ſets of diſtances of the moon's limb from a ſtar, near the time of the conjunction, both from the bright and the duſky parts of the circumference, and having calculated the reſults, I found that thoſe taken from the duſky part were much nearer the truth than the others: the nature of the error evidently ſhewed, that the ſtar had really been at ſome diſtance from the limb, when it appeared to be in contact with it; and, as the error was a conſiderable part of a degree, I ſaw it would be of conſequence to diſcover the cauſe of it; which however was obvious enough from Newton's principles, and may be explained as follows.

Let AD be the diameter of the moon, and A the center of a ſtar in contact with the moon's limb; now as the enlightened part of the moon evidently appears to extend beyond the duſky part, let the concentric circle BC repreſent the moon's limb thus apparently magnified, and ſuppoſe the ſtar to be equally magnified; then with the center A, and the diſtance DC deſcribe a circle, which conſequently will touch the moon's apparent circumference inwardly; now as this laſt is a conſequence of ſuppoſing the center of the ſtar to touch the circumference of the moon, excluſive of the deception, it follows, that *the proper method of taking the diſtance, is to make the ſtar appear to touch the moon inwardly.*

But, all the writers on this ſubject have particularly directed that the ſtar be made to touch *outwardly:* let B therefore be the point of contact, and *a* the center; the error then is Aa, or the ſum of the apparent increaſe of the moon's radius and the apparent radius of the ſtar: this quantity it is evident will make a conſiderable error in the reſult, and errors ariſing from this ſource are the more to be attended to, as they are not of a kind to be leſſened by increaſing the number of obſervations. The ſame reaſoning is applicable to the ſun and moon with very little alteration.

The diſtance of the moon from the ſun or a ſtar, at each three hours, is given in the Nautical Ephemeris, and the method of inferring the time, for any intermediate diſtance, is by ſimple proportion: this would be juſt if the moon's motion was uniform: but as that is not the caſe, the velocity ſhould be taken into the account, as well as the ſpace, in determining the time, taken by the moon to move any given diſtance; and the proper meaſure of the velocity is ſuch a quantity, as has the ſame ratio to the ſpace deſcribed, as three hours have to the time, that has been actually taken to move the given diſtance: to find this quantity correctly would require interpolation, but it will be ſufficient in practice to find the time firſt by the common method, and then to correct the interval for three hours to that time, by taking a proportional part of the ſecond difference of the moon's diſtance at the beginning of each three hours; ſuppoſing the firſt differences to anſwer to the middle of each interval.

The laſt correction, though not ſo conſiderable as the firſt, will often bring the reſult nearer to the truth by three, four, five, or ſix miles, and ſometimes more, which in geographical determinations is of conſequence; and, by paying attention to thoſe and ſome other cauſes of error, which ſhall be pointed out hereafter, the reſults in general will be much nearer to the truth than is uſually imagined.

Meteorological

Meteorological Journal, kept by Col. PEARSE, *from March* 1, 1785, *to February* 28, 1786, *abſtracted.*

	Barometer		Hygrometer		Thermometer within		Thermometer without		Prevailing winds.		Rain.	
	day	inches	day		day		day		weeks	weeks	Inch.	day
Greateſt	9	30,032	—	—	28	87°,5	—	—	1.SSW	3.SWbS	0,259	13. greateſt
Leaſt	13	29,770			11	70,0			2.SSE	4. S	0.554	Whole.
March	The firſt part of this month remarkably foggy, a great deal of thunder and lightning, the middle part very ſtormy, and the latter part thick and gloomy.											
Greateſt	16	29,990	25	53,5	30	91,0	12	100°,5	1.Var.	3.Var.	1,314	17. greateſt
Leaſt	17	29,705	16	15,0	17	70,5	21	73,5	2.SSW	4.SWbS	4,308	whole.
April	The greateſt part of this month was thick cloudy weather; on the 1ſt, 11th, and 27th, was thunder.											
Greateſt	6	30,000	1 & 2	47,5	24	92°,3	24	101°,0	1.SSW	3.Var.	0,697	31. greateſt
Leaſt	24	29,502	16	17,5	11	79,5	6	72,0	2.Var.	4.SSW	3,690	whole.
May	Looſe ſcattered clouds till the 6th, then much lightning and heavy thunder, with wind, which continned almoſt every day through the month.											
Greateſt	9	29,657	27	59,5	1	89,0	1	103°,0	1.Var.	3.Var.	3,250	23. greateſt
Leaſt	30	29,224	1	37,0	18	79,0	1 & 9	77,0	2.SbyE	4SWbW	18,611	whole.
June	The beginning with exceſſive thunder and lightning, many thunder ſhowers in the month, but rain almoſt every day, on the 10th, 18th, 23d, and 24th, the pluviameter overflowed, and 7,450 muſt be added to 18,611, = 26,061.											
Greateſt	26	29,686	22	64,0	30	86°,5	10	94°,0	1. E.	4SWbW	1,700	26. greateſt
Leaſt	31	29.370	2	47,5	31	80,0	19	78,0	2. S.	4. S. E.	10,392	whole.
July	1ſt, Cloſe hot air with thunder, many thunder ſhowers in the month, but rain almoſt every day; on the pluviameter overflowed as much as it retained, 1,700 is therefore to be added to 10,392 = 12,092.											
Greateſt	28	29,758	11	67,5	20	90°,0	20	93°,0	1. S. E.	3.S.W.	1,707	31. greateſt
Leaſt	16	29,460	20	40,0	9	80,0	8 & 18	78,5	2.Var.	4. S. E.	10,661	whole.
Auguſt	Thunder and rain almoſt every day: the rain on the 31ſt was a great deal more, but the overflowing could not be aſcertained.											
Greateſt	10	29,820	3	71.0	6 & 10	88°,0	13	93°,0	1.SSW	3.Var.	2,640	29. greateſt
Leaſt	28	29,556	7	45,0	30	78,2	29	79,5	2. S. E.	4 S.	7,032	whole.
September	The month began with violent wind, the firſt half was moſtly thunder, after almoſt continued rain, on the 29th the rain was from a violent ſtorm with thunder and lightning.											
Greateſt	24	29,936	1	58,5	25	88°,0	5	90°,5	1.WNW	3. N.	0,920	28. greateſt
Leaſt	28	29,724	2	37,0	28	77,0	10	75,5	2.WNW	3.N.E.	2,863	whole.
October	Firſt part thin clouds with ſtrong winds, then frequent thunder till 16th; fair till 20th, cloudy till 26th, then foggy at the end.											
Greateſt	12,13	30,118	—	—	2	85°,5	17	72°,3	1. N.	3. NW	1,000	9. greateſt
Leaſt	5	29,802			29	66,0	29	58,0	2. N.	4. N.	1,023	whole.
November	The beginning thick clouds with ſome rain, on the 9th a ſtorm of wind and rain. Scattered clouds till 23d, ſerene weather to the end.											
Greateſt	29	30,088	23	45,0	9 & 22	79°,5	19, 20	78°,0	1. N.	3. N.	—	—
Leaſt	6	29,070	24	43,0	16	53,0	16	48,5	2.WNW	4.WNW		
December	Thin ſcattered clouds in the beginning, 2d and 3d weeks foggy, the laſt fair weather, no rain this month.											
Greateſt	7	30,248	—	—	6	75°,5	27	87°,0	1. NW	3. NW	—	—
Leaſt	13	29,998			13	59,5	23	47,0	2. NW	4. N.E.		
1786, Jan.	The whole of this month a cold fog.											
Greateſt	6	30,100	—	—	13	80°,5	15	86°,0	1NWbW	3.Var.	0,420	17. greateſt
Leaſt.	22	29,882			19	65,0	4	55.0	2.W b N	4.Var.	0,936	whole.
February.	The firſt half exceſſive thick fog, then thunder, with thick ſcattered clouds to the end. On the 17th the thunder was uncommonly heavy.											

Tranſactions of the LINNEAN SOCIETY, *Vol. I.* 1791.

I. *Introductory Diſcourſe on the Riſe and Progreſs of Natural Hiſtory. Delivered by the Preſident, Doctor* J. E. Smith.

AFTER touching upon the probable ſtate of knowledge in the earlier periods of the world, the Preſident begins the real hiſtory of ſcience with *Ariſtotle*, who laid the foundation of all the knowledge of the animal kingdom which we now poſſeſs. *Theophraſtus*, his diſciple, gave in ſhort ſketches the firſt ſcientific views of the vegetable and mineral kingdoms. *Pliny*, ſeveral ages after, left a compilation of all that was known, or rather imagined, of natural hiſtory, down to his time. The works of *Dioſcordes* are nothing elſe than a materia medica, and it is extraordinary that he ſhould have acquired the title of the father of botany.

For the ſhadow of ſcience that ſubſiſted among the Arabians in the dark ages, as alſo for an account of all the Greek and Roman authors who touched upon botany, the writer refers to Haller's Biblioth. Botanica.

The age of commentators follows, beginning with the revival of literature in the fifteenth century; when the works of the ancients, and particularly of Dioſcorides, were aſſiduouſly ſtudied by the medical botaniſts. Some of theſe had much original merit in giving figures of plants, of which ſome are executed with wonderful perfection. *Brunfelſius* was the firſt of theſe authors, and was ſucceeded by *Matthiolus*, (the moſt celebrated of all the commentators on Dioſcorides) and *Fuchſius*. Their example was followed by a multitude of others; and for almoſt two centuries, the attention of naturaliſts was chiefly confined to the vegetable creation.

The inſtitution of public gardens is a memorable æra in botany, of which the firſt was at Padua in 1533. Theſe have become extenſive in proportion to the commerce of the countries in which they were eſtabliſhed; and the Engliſh gardens are at preſent by far the richeſt in the world.

Among the naturaliſts who flouriſhed from the middle to the end of the ſixteenth century, the Preſident ſelects a few conſpicuous names, beginning with *Conrad Geſner*, who was born at Zurich in 1516, and died in 1565. He was a man of wonderful ſtudy and obſervation, of a philoſophical genius, and deſerves particular honour as the firſt who ſuggeſted a methodical arrangement of plants into claſſes, orders, and genera, from the ſtructure of the flowers. *Aldrovandus* had equal induſtry and zeal in the purſuit of knowledge, and devoted to it his life and fortune, but he did not poſſeſs the ſyſtematic genius of Geſner. He died in 1605, aged 80, and his memory is much honoured at Bologna, the univerſity of which poſſeſſes his literary relics. *Cluſius* enriched botany with the publication of a vaſt number of new plants. He was profeſſor of botany at Leyden, and died in 1609, at the age of 84. *Cæſalpinus* was a profound metaphyſician, a great anatomiſt, and one of the moſt able promoters of botany. His method is chiefly founded on the fruit. He has thrown more light on the ſtructure and affinities of vegetables than any one before him, and has diſtinctly mentioned the ſexes of plants. He died in 1603.

During this period botany began to be attended to in England. *Turner* publiſhed his herbal in 1551; *Lyte* ſoon after gave a tranſlation of Dodonæus; and the firſt edition of *Gerard's* herbal appeared in 1597. *Lobel*, who began to publiſh in London in 1570, was a native of Flanders.

Fabius Columna, who firſt gave copper-plates of plants, and of almoſt unrivalled accuracy, publiſhed at Naples in 1592. He was an able critic, and ſhewed great ſagacity in determining ſome plants of the ancients, and detecting the errors of Pliny and other authors. The inſtitution of the academy of the *Lyncæi* at Rome in 1607, deſerves to be remarked as the firſt ſociety of the kind, and in ſome meaſure the model of all the preſent literary ſocieties in Europe. Its chief promoter was *Frederic Ceſius*, a young Roman nobleman; and *Columna* and *Galileo* were in the liſt of its members.

In the earlier part of the ſeventeenth century, great ſervices were rendered to botany by the illuſtrious brothers, *John* and *Caſpar Bauhin*. *John Bauhin*, from critical inveſtigations of the works of others, joined to his own obſervations, compiled an Univerſal Hiſtory of Plants, which he left in MS. at his death in 1613, but was not publiſhed till 1650. But *Caſpar Bauhin* performed a much more original and important work, and which makes an æra in botany; this was the publication of his Pinax Theatri Botanici, in 1623. It was the labour of forty years, and was meant as an index to all the botanical knowledge exiſting, containing about ſix thouſand plants arranged in a kind of ſyſtem, each diſtinguiſhed by a deſcriptive name, under which are placed the names given it by every preceding author. Notwithſtanding its imperfections, it was a work of ſuch great utility, that it continued to a late period to be the general dictionary of botaniſts, and is ſtill conſulted with advantage. *Caſpar* undertook various other great works; and diſtinguiſhed himſelf likewiſe as a phyſician and an anatomiſt. He died in 1624, aged 64. His herbarium is ſtill exiſting at Baſil.

Botany now languiſhed for nearly half a century, producing only inferior writers, with the exception of *Jungius*, who has given great proofs of ſagacity in his Doxoſcopiæ Phyſicæ minores. The Preſident employs this interval in tracing the progreſs of zoology from the middle of the ſixteenth to the end of the ſeventeenth century.

The Ariſtotelian diviſion of animals into viviparous and oviparous, was tranſmitted unchanged to *Geſner*, who arranged after it his voluminous hiſtory of animals; and *Aldrovandus*, in his collections, followed nearly the ſame order. Geſner cultivated ornithology with peculiar ſucceſs, as did afterwards *Belon*. The hiſtory of fiſhes was ably treated by *Paul Jovius*, *Belon*, *Salvianus*, and *Rondeletius*; and that of inſects by Geſner and others.

In this ſtate of zoology, *Harvey* made his attack upon the Ariſtotelian doctrine of equivocal generation, and maintained the propoſition "*omnia ex ovo*," and alſo made public his moſt important diſcovery of the circulation of the blood; and with him begins the phyſiological period of natural hiſtory. *Redi's* experiments to diſprove equivocal generation, and *Malpighi's* inveſtigations relative to the changes of ſilkworms, and the developement of the chick in the egg, were admirable ſpecimens of this mode of advancing knowledge. About the middle of the ſeventeenth century, the doctrine of the ſexes of plants was propoſed, as it is ſaid, by Sir *Thomas Millington*, who however wrote nothing himſelf; and about the ſame time *Rudbeck* or *Bartholin* made the diſcovery of the lymphatic ſyſtem. Syſtematic zoology could not fail of deriving advantage from theſe new points of knowledge, and towards the latter end of the century appeared two great naturaliſts, qualified to profit by them, *Willughby* and *Ray*. Theſe illuſtrious friends laboured in concert with the greateſt ardour. The former died young, but all his acquiſitions, as well as his juſt fame, were preſerved in the writings of the latter.

Ray was the inventor of a new claſſification of animals, founded on the ſtructure of the heart. Taking the ancient diviſion of animals into Sanguinea and Exanguia; he ſubdivides the firſt into ſuch as breathe by lungs, and ſuch as breathe by gills; and the former of theſe he ſeparates into thoſe which have a heart with two ventricles, and thoſe whoſe heart has only one. The Exanguia are divided into greater and leſſer. There are other ſubdiviſions in this ſyſtem, which, though liable to many objections, is deſerving of great praiſe. The botanical merit of *Ray* will hereafter be mentioned. On the ſubject of zoology, *Leeuwenhoek*, the author of the now-exploded vermicular theory of generation, as well as of many genuine diſcoveries in phyſiology, deſerves to be noticed.

The *Royal Society of London*, inſtituted in 1662, from their very beginning paid great attention to the phyſiological part of natural hiſtory. The royal botanic gardens of Paris and Montpellier, and the *Academies of Sciences* eſtabliſhed at both thoſe places, promoted in France equal ardour in the purſuit of natural knowledge. By the munificence of Louis XIV. *Tournefort* was ſent to the Levant on a botanic miſſion, and *Plumier* made three voyages to America for a like purpoſe. In Germany, the Imperial Academy *Naturæ Curioſorum* was inſtituted in 1652; and a number of botanic gardens were eſtabliſhed. The gardens of Holland were, however, much richer in exotic plants; and that of Amſterdam and Leyden became highly celebrated. Holland alſo had the glory of producing the *Hortus Malabaricus*, which laid open the choiceſt treaſures of Aſia to the European botaniſt.

But the ſtudy of nature was nowhere making greater progreſs than in Sweden, where *Rudbeck* at Upſal was laying the foundation of an unrivalled ſchool of natural hiſtory. *Rudbeck* poſſeſſed the moſt profound and extenſive learning, being a great anatomiſt, an excellent antiquarian and proficient in the learned languages, and a conſummate botaniſt. In the laſt ſcience, he undertook a vaſt work, a collection of fine wooden cuts of all the plants known, arranged according to Bauhin's Pinax. It was to have compoſed 12 vols. folio; but after two were printed, moſt of the copies, and the blocks for all the reſt, were conſumed by fire.

The idea of a claſſical arrangement of plants was now revived by *Moriſon*, whoſe method was founded chiefly on the fruit. The only work claſſed according to it was his own Hiſtoria Univerſalis Plantarum, an uſeful compilation, which has ſurvived the neglect into which his ſyſtem is fallen. But the three principal ſyſtematic authors were *Ray*, *Tournefort*, and *Rivinus*, between whom there took place much warm controverſy. Ray's method was abſtruſe and ſcientific, and founded chiefly on the fruit. That of Rivinus, founded on the corolla, was ſimpler, but liable to great difficulties in the execution. Tournefort's, founded principally on the corolla, was ſuperior to the reſt; but his peculiar excellence was the diſcriminating of the *genera* of plants, not indeed by words, but by figures and deſcriptions. This eminent botaniſt and traveller arrived at a reputation in his own country, which was ſomewhat injurious to his ſucceſſor *Vaillant*, a man of profound knowledge in the ſcientific part of botany, and one of the firſt who was well acquainted with the ſexes of plants. About this time ſeveral other botanical ſyſtems were invented, of which the beſt were *Herman's*, founded entirely on the fruit; and *Boerhaave's*, on all the parts of fructification. That of Profeſſor *Magnol* of Montpellier, founded on the calyx, was a favourite with Linnæus. Vaſt additions were made during this period to the catalogue of known plants. Beſides thoſe collected by Tournefort, Plumier, and Ray, Dr. *Sloane* brought a noble collection

collection from Jamaica; Mr. *Sherard*, conſul at Smyrna, ſent home a great number; *Plukenet* procured and publiſhed an immenſe collection from all parts of the world; *Petiver* was an induſtrious collector of all kinds of natural productions; *Herman* made conſiderable acquiſitions in Ceylon; and *Rumphius* diſplayed the rich treaſures of Amboina.

Entomology now began to be aſſiduouſly cultivated, and the propagation and metamorphoſes of inſects were the object of the enquiries of ſeveral able men, among the firſt of whom were *Goedart* and *Swammerdam*. Conchology likewiſe had its votaries, and towards the end of the century was elucidated by two eminent writers, *Bonanni* and *Liſter*. Of all the parts of natural hiſtory, Mineralogy made the ſloweſt progreſs; few improvements having been made in it from the time of Theophraſtus to the end of the ſeventeenth century. And though it afterwards was cultivated with more care, this was ſtill on wrong principles, and it was not till lately eſtabliſhed on its proper foundation, chemical analyſis.

Little was done in botany in the beginning of the preſent century till 1718, when *Ruppius* publiſhed his Flora Jenenſis, which was followed the next year by *Scheuchzer's* Agroſtographia, and *Dillenius's* Flora Giſenſis. About the ſame time flouriſhed *Pontedera* at Padua, a ſcientific botaniſt, though greatly prejudiced againſt the ſexes of plants. Dillenius, who was one of the firſt botaniſts for accuracy of obſervation and judicious criticiſm, removed to England, where he publiſhed, in 1724, his excellent edition of Ray's Synopſis Stirpium Britannicarum. By his efforts, and the encouragement of Sloane and the Sherards, botany made great progreſs in this country; but the multiplicity of ſyſtems, all of them labouring under defects, rendered botaniſts in general perplexed about arrangement, and the ſcience was in danger of ſinking under its own riches.

In this ſtate of things, a turn was given to botany, and indeed to all natural hiſtory, by the publication of the Syſtema Naturæ & Fundamenta Botanica of LINNÆUS in 1735, who two years after, gave to the world his Critica Botanica, Genera Plantarium, Hortus Cliffortianus, Flora Lapponica, and Methodus Sexualis; works every one of which might have been ſufficient to confer immortality on its author. The botanical ſyſtem of Linnæus, founded on differences in the number, ſituation, and proportion of the ſtamina and piſtilla, or ſexual organs, of plants, is profeſſedly an *artificial* one; but it coincides with nature in many points, and in facility and univerſality is decidedly ſuperior to all hitherto invented. The invention of this ſyſtem was, however, only a part of his praiſe; for beſides new modelling and defining all the known genera of plants, he endeavoured likewiſe to define the ſpecies upon philoſophical principles; a thing before almoſt unattempted.

Nor were his abilities leſs conſpicuous in arranging the animal kingdom. The firſt edition of the Syſtema Naturæ was only a ſketch of this deſign, which was ſucceſſively corrected and enlarged. In this ſyſtem, the claſſes of birds and inſects were entirely original. His arrangement of foſſils was leſs happy, and is become obſolete.

Linnæus returned to his native country, Sweden, in 1739, and there fixed the throne of natural hiſtory. He aſſiſted in founding the Academy of Sciences at Stockholm, of which he was the firſt preſident; and his medical and botanical lectures at Upſal attracted ſtudents from all parts of the world.

The moſt intimate companions of Linnæus at the beginning of his career were *Artedi* and *Gronovius*; the former author of an excellent work on Ichthyology; the latter eminent both in botany and zoology. He had alſo firſt a friend, and then a rival, in the illuſtrious *Haller*, one of the greateſt and moſt extenſive geniuſes in any age, and peculiarly excellent in phyſiology, anatomy, and botany. His work on the plants of Switzerland is one of the moſt perfect of the kind ever produced, though his diſlike of the Linnean claſſification and nomenclature have rendered it much leſs uſeful than it might otherwiſe have been. *Reamur* is another diſtinguiſhed name of this period. To him the philoſophical world is obliged for various inveſtigations of the moſt intricate parts of natural hiſtory. His capital work is his "Memoires pour ſervir a l'Hiſtoire des Inſectes," in 6 vols. 4to. The Italians poſſeſſed a ſimilar genius in *Valiſneri*, whoſe experiments on generation and inveſtigations of inteſtinal animalculæ, deſerve great praiſe. *Micheli* of Florence, publiſhed in 1729, his Nova Genera Plantarum, a fundamental work in botany, containing original and accurate obſervations on thoſe difficult vegetables, graſſes, moſſes and fungi.

In 1741, *Dillenius* publiſhed his Hiſtoria Muſcorum; unrivalled for accurate delineation and diſcrimination of ſpecies. The Hierobotanicon of *Olaus Celſius*, for the completion of which he travelled into the Eaſt, is an extraordinary monument of labour. Great ſervices were about this period rendered to philoſophical botany by two writers who diſtinguiſhed themſelves in vegetable phyſiology, *Duhamel* and *Hales*.

Mean time Linnæus was advancing his reputation by new works of great merit. Among theſe, the Philoſophia Botanica, which appeared in 1751, and the firſt edition of the Species Plantarum which ſoon followed, were peculiarly diſtinguiſhed. The latter was remarkable for the firſt introduction of *trivial names*, an invention of ſingular utility in natural hiſtory. His fame now became ſo widely diffuſed, that he had diſciples in every part of the world, who vied with each other in enriching his collections with every article which they could procure. This was, in fact, a moſt flouriſhing period of natural hiſtory, numbers being employed in practical obſervations and diſcoveries, while Linnæus, informed of every thing, ſuperintended and methodiſed the whole. About this time ſome very ſuperb works in natural hiſtory appeared; as *Seba's* Theſaurus Rerum Naturalium; *Cateſby's* Nat. Hiſt. of Carolina, &c. *Edwards's* Hiſtory of Birds; and ſome others. At Florence was publiſhed *Gualtieri* Index Teſtarum Conchyliorum, remarkable for the excellence of its ſpecific differences of ſhells.

In England, Agriculture made great advances under the celebrated *Miller*, and many American plants were ſent home by *Bartram* and *Houſtoun*. In Holland, botany was ably ſupported by the two *Van Royen's*, at Leyden, and *Burman*, at Amſterdam. In Germany, Profeſſor *Ludwig* of Leipſic enjoyed a deſerved reputation. France admitted more ſlowly than any country the improvements of Linnæus, which was partly owing to the national attachment to Tournefort, and partly to their poſſeſſion of ſome admirable botaniſts, of ſufficient conſequence to ſupport any ſyſtem they ſhould prefer. Among theſe, the *Juſſieus* claim the firſt place. In the ſouth of France, however, Linnæus had more admirers. Profeſſor *Gouan* of Montpellier adopted his principles both in his ichthyology and botany; and *Gerard*, though he did not follow his method, was cloſely attached to his principles. At Berlin, Profeſſor *Gleditſch* was a warm ſupporter of the Linnean ſyſtem, and an induſtrious inveſtigator of the phyſiology of the fungi and other obſcure vegetables. He alſo publiſhed many excellent treatiſes relating to rural economy in the Berlin Memoirs; and was the author of a new ſyſtem of botany, founded on the ſituation of the ſtamina. Catalogues of the plants of particular places, were now multiplied; a ſpecies of compoſition which the Preſident defends againſt the cenſures of ſome faſtidious critics.

Great ſervices were rendered to natural hiſtory by the diſciples of Linnæus and others, who undertook toilſome and hazardous journies for the purpoſe of exploring new regions. The Peterſburg Academy led the way by ſending *Buxbaum* to the Levant, the fruits of whoſe labours were but indifferent; and *Gmelin* to Siberia, whoſe Flora Sibirica is one of the beſt performances of the kind.

Of the Linnean miſſionaries, the firſt was *Ternſtroem*, who took a voyage to China in 1745, and died at Poulicandor. *Kalm* viſited North America in 1747; *Haſſelquiſt* went to Egypt and the Holy-land in 1749; and *Oſbeck* to the Eaſt Indies in 1750. Their reſpective travels are made known to the Engliſh reader by tranſlations. *Loefling* examined Spain in 1751, and left it for South America, where he died. His letters have been publiſhed by his maſter. Various other expeditions of leſs note were undertaken; among which it is to be regretted that we have had no more information from *Rolander*, who viſited Surinam and St. Euſtatia in 1755, and whom Linnæus eſteemed the firſt entomologiſt after Reaumur. *Toren's* obſervations in the Eaſt Indies were publiſhed with Oſbeck's.

The Preſident next finds himſelf led to conſider ſome of the illuſtrious naturaliſts of the preſent age, whoſe works and diſcoveries are ſo well known, as almoſt to preclude the neceſſity of mentioning them, were it not neceſſary to the uniformity of his plan. But as this reaſon does not operate upon us, and as the notices of a number of authors in the compaſs of a very few pages are neceſſarily very ſhort, and rather complimentary than critical, we ſhall not attempt to follow him in a ſtill more conciſe abridgment.

He concludes with pointing out what he conceives to be the peculiar objects of the *Linnean Society*. A particular regard to the productions of their own country, is mentioned as the firſt thing which may be expected from them. Our riches in public gardens and cabinets now exceed thoſe of any other country, but that ſo many rareties ſhould ſtill remain undeſcribed, cannot but be thought a reproach to the Britiſh naturaliſts. A ſtrict attention to the laws and principles of Linnæus, ſo far as they have been found to be good, is another point. Working on them as a foundation, will contribute much more to the advantage of natural hiſtory, than futile attempts to make new ſyſtems or arrangements. At any rate, his laws with reſpect to the conſtruction of *generic names* and *ſpecific differences* ought to be ſtrictly adopted by the ſociety. A further object which they may be expected to purſue, is the accurate determination of the ſpecies deſcribed by Linnæus, and of many other authors. The various advantages before mentioned, together with their acceſs to the immenſe herbarium of Sir Joſeph Banks, and more eſpecially to the herbarium and muſeum of Linnæus himſelf, will afford them advantages not to be met with elſewhere. With reſpect to the Linnean remains, of which the Preſident has fortunately become the poſſeſſor, he conſiders himſelf only as a truſtee of them for the public, and that he holds them for the ſole purpoſe of making them uſeful to the ſtudents of natural hiſtory in general, and of this ſociety in particular, to which he conſecrates his labours and beſt ſervices.

II. *Obſervations on ſome extraneous Foſſils of Switzerland. By Monſ.* TINGRY, *Foreign Member of the Linnean Society, Demonſtrator of Chemiſtry and Natural Hiſtory, &c. at Geneva.*

EACH quarter of the globe which we inhabit, contains in its boſom the impreſſions and configurations of many animals and vegetables which appear foreign to its preſent clime. America, and Europe yield to the naturaliſt fragments of organized bodies, the living reſemblances of which are now only in India, and Aſia; and it is to be preſumed if India, and Aſia were better known, they would afford us further proofs of this curious fact.

Formerly Coal, Petroleum, Bitumens, Naphtha, and other mineral inflammable bodies were ſuppoſed to be the produce of certain exhalations from the earth, but as oil is generated only by organized bodies, it is not to be conſidered as the reſult of unorganized matter, hence philoſophers were led to conſider theſe ſubſtances as ariſing from the decompoſition of animal, and vegetable matters.

The author, contrary to the opinion of Meſſrs. Fourcroy, Parmentier, and other French Philoſophers, looks on theſe inflammable bodies as owing their origin more to the decompoſition of vegetables than of animals.

“One may reaſonably conjecture that fragments of vegetables collected into great maſſes, and expoſed either to the action of ſuch ſort of combinations as give heat to the warm ſprings, or to volcanic fires, ſhould ſuffer a true diſtillation, the produce of which waſhed away by the waters appears at the ſurface of the earth, in the form of Naphtha: or that in other circumſtances theſe ſame oils detached by ſpontaneous decompoſition filtrate themſelves amongſt the layers of ſand and clay, giving origin to dry oils and bituminous ſhiſtus. Laſtly, that in other circumſtances and which are only a conſequence of the preceding ones, theſe oils ſhould be collected in the interior fiſſures of the earth, and take on the conſiſtence of mineral pitch.”

The obſervations which the author made in the bituminous mines of the Tarentaiſe, and in ſome other ſimilar mines of France, and Switzerland, have not yielded him any proofs in favour of the French Hypotheſis.* In all theſe mines indeed he has found remains of teſtaceous fiſh imbedded in the ſtrata, lying above the vein, and in the body of the mountain, but none of them bore the marks of bituminiſation. The impreſſions of vegetables, on the contrary, are evident, even the maſs of coals.

Of late the author has been ſtill more fortunate in his reſearches, for in ſome veins of inflammable ſubſtances lately diſcovered in Savoy, he has found carboniſyed plants which had not loſt any thing of their organic appearance. The ſpecimens which he has ſent to the Linnean Society, confirm the ingenious remark of the celebrated Bernard de Juſſieu, relative to the impreſſion of many inſects and vegetables found in the mines of Europe, which is, that the recent or living ones of the ſame kind are now to be met with only in India and America. Theſe veins of Petroleum, &c. were found a little way above Teninge, in the province of Faucigni, in Savoy. The ſpecimens were collected from the rubbiſh taken from the roof of the veins. The mountain is calcareous, and contains many ſhells. See Plate 3, Fig. 1.

Obſervations

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* If animal ſubſtances contributed to the formation of coal, we ſhould expect to find the moſt unequivocable proofs of it in thoſe enormous aſſemblages of ſhells, which compoſe the mountains of St. Peter, near Maaſtricht, and in thoſe immenſe tracts of ſhells found in France. There is no coal however, to be found there, and if it is found the traces of vegetables are eaſily to be diſcovered.

III. *Obſervations on the Phalæna Bombyx Lubricipeda of Linnæus, and ſome other Moths allied to it.* By THOMAS MARSHAM, *Eſq. Secretary to the Linnean Society.*

THIS paper is written with a view to correct an error into which the celebrated Linnæus has fallen in deſcribing his Phalæna Bombyx Lubricipeda, which he has confounded with three other ſpecies.

The author expreſſes a wiſh that Entomology were more ſtudied as a ſcience, and enforces what he ſays by many juſt and ſtriking obſervations. "An entomologiſt ſhould always endeavour to be acquainted with his inſect in all its changes, as a good botaniſt always deſires to know his plant in every ſtage of its growth. Varieties in the ſame ſpecies of inſect are certainly not ſo numerous as many have conjectured; for though nature frequently ſports in this way in the Lepidoptera Claſs, where we ſee different markings and ſhades of colour in the ſame ſpecies, as in Phal. Geom. Prunaria, Defoliaria, &c.; yet an accurate eye will ſoon diſtinguiſh ſome conſtant characteriſtic mark which never fails to run through and unite them: for example, the long comma-like mark in the firſt inſtance, and the roundiſh dark ſpot in the ſecond; neither of which ever vary. The diſtinction of ſex is indeed variouſly marked, and requires peculiar attention. Some larvæ produce winged males and apterous females, which are ſo totally different in their appearance, that it would be impoſſible to determine them to be the ſame ſpecies, if we were not acquainted with their hiſtory. Some females again have ſmall, or as it were only rudiments of, wings; and others differ from the males ſo much in colour as not to appear ſimilar. In ſome claſſes the diſtinction is ſtrongly marked by the antennæ; in others one ſex is furniſhed with horns, of which the other is deſtitute. So that a conſiderable degree of attention is requiſite before we attempt to determine; and therefore thoſe entomologiſts are moſt to be depended upon, who are at the pains to trace their inſect through its different changes from the egg to its perfect ſtate; thus acquiring truth from the fountain head. And to ſuch I would particularly recommend a ſcientific arrangement, that their obſervations may be more diffuſed, and become generally uſeful."

Mr. Marſham then proceeds to the deſcription of the Phal. Bom. Lubricipeda and Mendica, to which he ſubjoins a drawing of four different Phalænæ, that appear to have much affinity in their three ſtates, and has added a ſpecific deſcription of each, together with the ſynonyms of various authors; by which it appears how much they have been miſquoted and miſapplied.

PHALÆNA BOMBYX. ERMINEA. *Cream Ermine.* B. Alis albis punctis nigris ſparſis, abdomine quinquefariam nigro punctato.

Linn. Syſt. Nat. 829. 69. lubricipeda. *Faun. Suec.* 1138. fœm.
Fab. Syſt. Ent. 576. 68. *Inſ.* 190. 93.
Gœd. Inſ. vol. 1. *tab.* 23. *fig.* 38. *Liſt. Gœd.* 96. *Rai. Inſ. fig.* 195. *n.* 40. *Albin. Inſ.* 24. *f.* 36. g—k. *Wilkes* 20. *t.* 3—5.
De Geer. Inſ. 1. *t.* 11. *f.* 8. *Roeſ. Inſ.* 2. *t.* 46. *Eſper. tom.* 3. *tab.* 66. *fig.* 6—10 Menthaſtri. *Harris Aur. pl.* 38. g—b. *Ernſt. Pap. d'Europe, pl.* 158. *n.* 204.

Habitat in arboribus pomiferis, urticâ, atriplici, quercu.
Expanſio alarum 1 unc. 6 lin.

Deſcrip. Femora, præſertim antica, lanugine ferrugineâ veſtita; *Corpus* album; *Alæ* adſperſæ punctis nigris plurimis in ſuperiorum paginâ ſuperiore; *Abdomen* luteum

quintuplici macularum nigrarum ordine, quorum unus dorſalis, duo utrinque laterales---Ano albo quo certo certius, a Ph. lubricipeda differt.

LUBRICIPEDA. *Cream Dot Stripe.* B. Alis luteſcentibus punctis nigris plerumque ordine oblique-tranſverſo poſitis.

Linn. Syſt. Nat. 829. 69. *β. Faun. Suec.* 1138. mas. *Fab. Syſt. Ent.* 576. 68. *Sp. Inſ.* 190. 93.
Gœd. Inſ. vol. 1. 38. *Liſt. Gœd.* 93. *Rai. Inſ.* 196. *n.* 155.
Merian Eur. 1. *t.* 46. *f.* 65. *Alb. Inſ.* 24. *f.* 35. a---d. *Friſch. Inſ.* 3. *t.* 8. *Ammiral, t.* 6.
De Geer. Inſ. 1. *t.* 11. *f.* 7. *Roeſ. Inſ.* 2. *t.* 47. *Wilkes* 20. *t.* 3---6. *Eſper. vol.* 3. *tab.* 66. *fig.* 1---5.
Harris Aur. pl. 16. h---l. *Ernſt. Pap. d'Eur. pl.* 157. *n.* 203.
Expanſio alarum 1 unc. 6 lin.

Deſcrip. Variat colore alarum albido et luteſcente. Maximè affinis Ermineæ, a quâ differt punctis pleriſque ſerie obliquâ poſitis; quod in illâ omnino deſideratur—— Anus variat pro re nata flaveſcentior; neque unquam albus.

MENDICA. *Spotted Muſlin.* B. Alis maſculis fuſcis obſcuris. } utriſque nigro-punctato.
—— fœmineis niveis pellucidis.

Linn. Syſt. Nat. 822. 47. *Faun. Suec.* 1127. mas. *Pet. Gaz.* 44. *fig.* 8. fœm.
Rai. Inſ. 196. *An.* 97. 6. fœm. *Reaum. Inſ.* 2. *t.* 1. *fig.* 1---9.
Eſper. vol. 3. *tab.* 42. *fig.* 1---9. *Harris Aur. pl.* 35. m.
Expanſio alarum } Mas, 1 unc. 1 lin.
Fœm. 1 unc. 5 lin.

Deſcrip. Mas. Alæ anticæ fuſcæ, maculâ albidâ, mediâ, obſoletâ, et punctis circiter 9 nigris, ſparſis---poſticæ concolores punctis 4 ſeu 5 nigris marginem verſus.

Fœmina. Alæ omnes pellucidæ, ſuperiores punctis circiter 9 nigris, ſparſis; inferiores circiter 7, marginalibus.

In utrâque antennæ nigræ, femora lutea.

PAPYRATIA. *Water Ermine.* B. Alis niveis, punctis ad apicem nigris, abdomine quinquefariam nigro punctato.

Albin. Inſ. 21. *f.* 30. e—h.
Expanſio alarum 1 unc. 6 lin.

Deſcrip. Maxime affinis Ph. Ermineæ, et alæ punctis ſolummodo ad apicem circiter ſex nigris; ſcilicet quatuor confertis in ipſo apice, longitudinaliter poſitis, et duobus intra hæc tranſverſim ductis, diſtantibus. Caput, thorax et abdomen ut in Ph. Erminea.

Larva habitat in plantis aquaticis.

IV. *Deſcriptions of four Species of Cypripedium. By* RICHARD ANTHONY SALISBURY, *Eſq. F. R. S. Fellow of the Linnean Society.*

MR. Saliſbury premiſes an obſervation, that the eſſential character of this genus by no means conſiſts in the calceiform lower lip of the corolla, but rather in the ſtructure of the genital parts, which are of great importance in diſtinguiſhing all of the orchis tribe.

The following are the ſpecies he deſcribes, with their ſynonyms and ſpecific characters.

Cypripedium Calceolus. Cypripedium Calceolus, *Linn. Sp. Pl. p.* 1340. Calceolus, &c. *Hall. Hiſt. Helv. v* 2. *n.* 1300. *t.* 42. Calceolus marianus *Dod. Pemp. p.* 180. *p.* 1, 2.

Corolla labio ſuperiore ovali concavo ſubtus carinâ late canaliculata, inferiore petalis breviore compreſſo.

Sponte naſcentem in *Oſtro-Bothniæ* ſylvis abunde legit C. Linné—prope *Bern* declivibus montium umbroſis legit A. Haller—in Monte *Saleve* legit J. Ray---*Pedemontii* ſylvis legit C. Allioni.

Floret fine Maii, Junio.

Cypripedium Parviflorum. Helleborine Calceolus dicta, mariana, caule folioſo, flore luteo minore *Plukn. Mantiſs. p.* 101. *t.* 418. *f.* 2. *peſſima.*

Corolla labio ſuperiore ſagittæformi baſi deflexo ſubtus carinâ anguſte canaliculatâ, inferiore petalis breviore compreſſo.

Sponte naſcentem in *Virginiâ* legit H. Marſhall.

Floret fine Maii.

Cypripedium Spectabile.* Helleborine flore majore purpureo, &c. *Moriſ. Hiſt. v.* 3. *p.* 488. *ſ.* 12. *t.* 11. *f.* 17. *peſſima.* Helleborine Calceolus dicta, mariana, flore gemello candido, venis purpureis ſtriato. *Plukn. Mantiſſ. p.* 101. *t.* 418. *f.* 3. *peſſima.*

Corolla labio ſuperiore ovali baſi retuſo concavo ſubtus carinâ obtuſâ, inferiore petalis longiore groſſo.

Sponte naſcentem in *Penſylvaniæ* ſylvis legit I. Bartram.

Floret fine Maii, Junio.

Cypripedium Humile.† Calceolus flore maximo rubente, &c. *Cateſb. Hiſt. Car. Append. p.* 3. *t.* 3. *mediocris.* Helleborine Calceolus dicta, mariana, foliis binis e radice ex adverſo prodeuntibus, &c. *Plukn. Mantiſſ. p.* 101. *t.* 418. *f.* 1. *peſſima.*

Corolla labio ſuperiore rhomboideo acuminato lateribus deflexo ſubtus carina anguſtiſſima obtuſa, inferiore petalis longiore antice fiſſo.

Sponte naſcentem in *Novâ-Scotiâ* legit A. Menzies.

Floret fine Maii, Junio.

V. *Deſcriptions of ten Species of Lichen collected in the South of Europe. By* James Edward Smith, *M.D. F.R.S. Preſident of the Linnean Society.*

1. LICHEN exanthematicus. L. leproſus cinereus, ſcutellis minutiſſimis carneis immerſis in cruſtæ foveolis albis.

Habitat in rupibus calcareis Galliæ auſtralis, non longe ab Avenione.

2. L. gypſaceus. L. cruſtaceus lobatus; interne albus; ſuperficie virenti, ſcutellis difformibus flaveſcentibus.

Habitat in rupibus Monſpelii & Genuæ.

3. L. tumidulus. L. cruſtaceus albus lobatus: lobis deflexis tumidis, tuberculis atris difformibus.

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* C. Album. *Aiton Hort. Kew. V.* 3. 303. † C. acaule. *Aiton Hort. Kew.* 3. 303.

Habitat in fiſſuris rupium Galliæ auſtralis.

4. L. ſaxifragus. L. cruſtaceus lobatus longiſſimè radicatus cæſius, tuberculis rubris.

Habitat in fiſſuris rupium Monſpelii.

5. L. chryſoleucus. L. imbricatus, foliolis lobatis obtuſis: ſupra pallide ſulphureis; ſubtus atro-viridibus, ſcutellis aureis.

Habitat in montis Ceniſii rupibus.

6. L. tiliaceus. L. imbricatus, foliolis ſinuatis lævibus cinereo albidis, ſcutellis badiis margine albido lævi.*

Habitat in corticibus oleatum Gallo-provinciæ et Genuæ.

7. L. encauſtus. L. imbricatus, foliolis linearibus dichotomis: ſupra albis nitidis; ſubtus nigris opacis, ſcutellis badiis.

Habitat in rupibus alpinis Sabaudiæ. In ſummitate montis *Montanvert* prope *Chamonix*.

8. L. corrugatus. L. foliaceus repens lobatus viridis, ſcutellis teſtaceo-ferrugineis concavis extus rugoſis folio concoloribus.†

Habitat in truncis arborum Galliæ borealis.

9. L. ſaturninus. L. foliaceus membranaceus lobatus atro-virens ſubtus villoſus pallidus, ſcutellis atro-ferrugineis ſparſis.‡

Habitat in truncis arborum ad ripas Rhodani prope Valentiam, & in Sabaudia.

10. L. cucullatus. L. foliaceus erectus laciniatus albus, ſcutellis poſticis cucullatis fuſcis.

Habitat in ericetis alpinis Sabaudiæ. Ex monte Ceniſio ad Cl. Bellardum miſi.

VI. *Some Obſervations on the Natural Hiſtory of the Curculio Lapathi and Silpha griſea.* By William Curtis, *Fellow of the Linnean Society.*

SEVERAL ſpecies of the willow are well known to be ſubject to the depredations of inſects, particularly of the larvæ of the *Phalæna Coſſus*, and the *Cerambyx moſchatus*. Mr. Curtis here lays before the ſociety an account of a new depredator, with ſome obſervations on the hiſtory of another inſect.

"In the beginning of June 1780, I obſerved a young tree of the *Salix viminalis* which had been planted in my garden two years, and which was now about ſix inches in diameter, throwing out from various parts of its trunk a ſubſtance ſomewhat reſembling ſaw-duſt, which fell at its baſe in no inconſiderable quantity. This ſubſtance, on a cloſer examination, was found to proceed from holes about the ſize of a gooſe quill, penetrating deeply into the ſubſtance of the wood, obliquely upwards and downwards. On its firſt coming out it appeared of the colour of the wood, and was moiſt; as it grew dry it became of a browner colour. The whole of the trunk where this internal operation was going forward emitted a ſmell ſomewhat like beer in a ſtate of fermentation; and various inſects allured thereby ſettled on the tree, and ſeemed eagerly to imbibe nouriſhment from it."

These

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* L. quercifolius. *Jacq. Coll. V.* 3. 127. *t.* 9. *f.* 2. fig. bona, ſed ſynonyma omnino erronea.

† L. acetabulum. *Jacq. Coll. V.* 3. 125. *t.* 9. *f.* 1. bona.

‡ L. ſaturninus. *Dickſ. Crypt. faſc.* 2. 21. *t.* 6. *f.* 8.

Facing pa. 61. *Plate 3.*

Fig: 1.

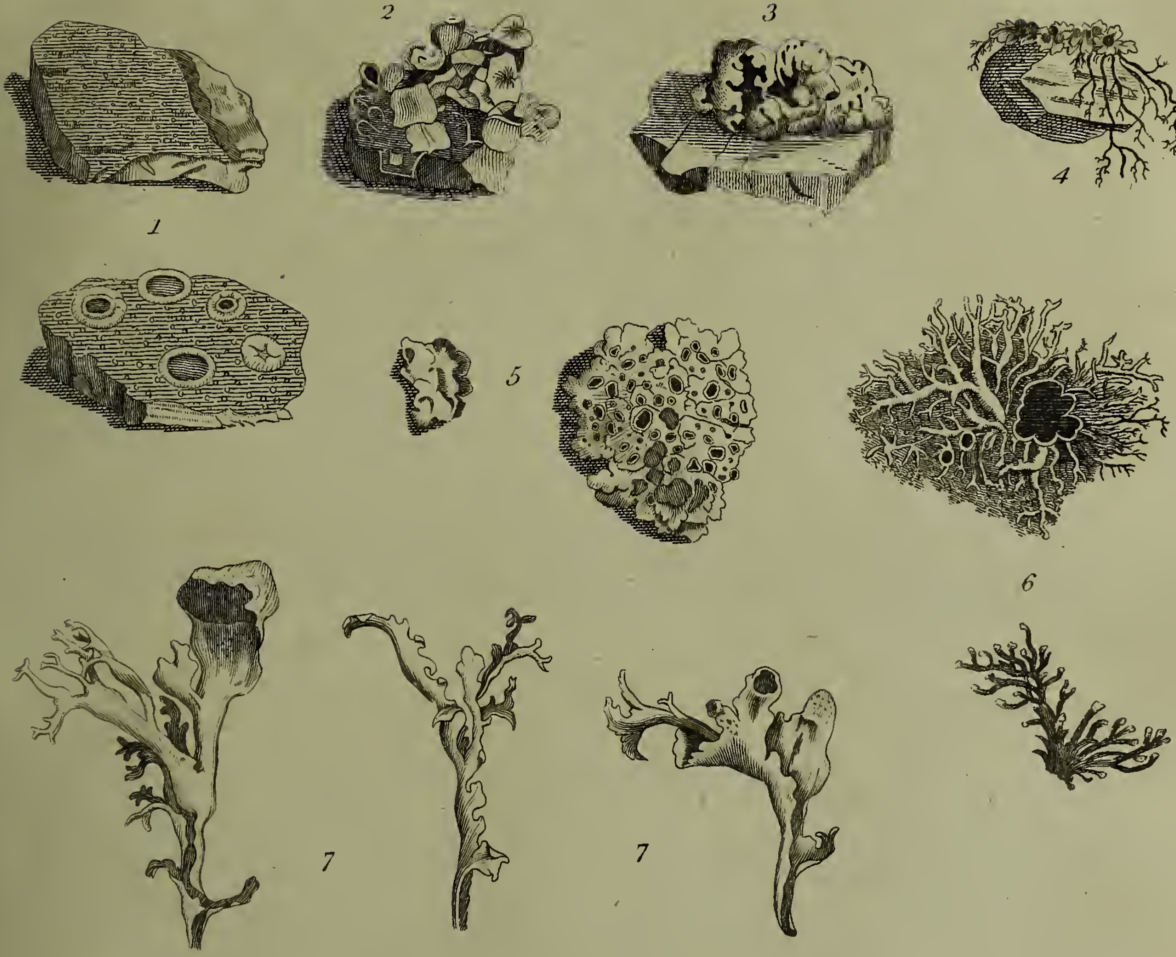
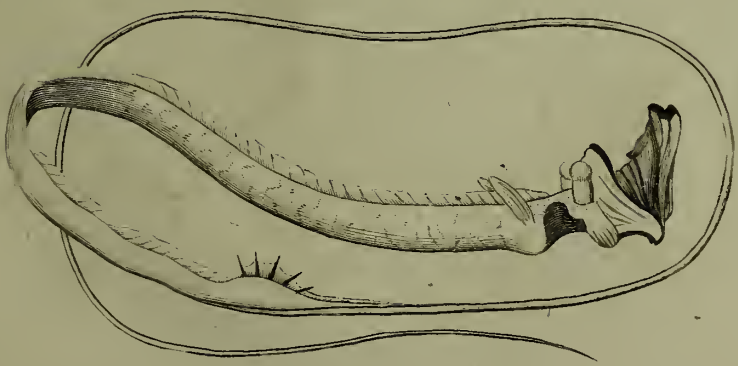


Fig: 2.

STYLEPHORUS CHORDATUS.



Theſe appearances excited his curioſity. He often viſited the trees, and on minutely examining its bark, he diſcovered ſeveral ſmall coleopterous inſects in its crevices, which he at firſt took for the *Cimex lectularius*, which they greatly reſembled; but on cloſer inſpection he diſcovered it to be the *Silpha griſea* of Linnæus, and in the moiſt fermenting ſaw-duſt, he found many larvæ feeding, which proved to belong to the ſame inſect. In order to diſcover the grand internal enemy of the tree, he had a piece chopped out, which brought to view ſome large maggots, about twice as big as thoſe of the hazel-nut, contained in cylindrical cavities which they had corroded in the ſubſtance of the wood. In July ſome of theſe were found in the pupa ſtate, and others juſt broke forth into the perfect inſect, which was the *Curculio Lapathi*, a ſpecies which he had ſome years before found in plenty on the leaves of the ſame kind of Salix. He had no opportunity of obſerving in what manner the female of this Curculio depoſits her eggs, but it is probably either in the bark, or in ſome crevice of the tree. As it is of much importance to prevent the entrance of the larvæ into the wood, he ſuggeſts covering any accidental wound of the tree with an adheſive reſinous plaſter, matting the trunks of young trees in the months of June and July, or bruſhing them over with ſea-coal tar.

VII. *Deſcription of the Stylephorus chordatus, a new Fiſh. By* GEORGE SHAW, *M.D. F.R.S. Fellow of the Linnean Society.*

THIS curious and uncommon fiſh, a native of the Weſt-Indian ſea, appearing to Dr. Shaw to conſtitute a new genus, he has thus laid down its generic characters,

Oculi pedunculati (ſeu cylindro craſſo brevi impoſiti).
Roſtrum productum, ſurſum ſpectans, verſus caput membrana interjecta retractile,
Os terminale, edentulum?
Branchiæ trium parium ſub jugulo ſitæ.
Pinnæ pectorales parvæ; *dorſalis* longitudine dorſi;
Caudalis brevis, radiato-ſpinoſa.
Corpus longiſſimum, compreſſum.

From the appearance of the branchiæ, and ſome other circumſtances, it cannot be doubted that this ſingular animal belongs to the tribe of Piſces, and from the want of ventral fins, it muſt be referred to the firſt Linnean order of Apodes. Its form will beſt be underſtood from the annexed plate, Fig. 2. Its whole length from the extremity of the caudal proceſs is about thirty-two inches, of which the proceſs itſelf is twenty-two.

VIII. *Deſcription of the Hirudo viridis, a new Engliſh Leech. By* GEORGE SHAW, *M.D. F.R.S. Fellow of the Linnean Society.*

THIS little animal ſeems hitherto to have entirely eſcaped the obſervation of naturaliſts; having no place in the Syſtema Nat. Lin. or in any other work on natural hiſtory.

It is to be found in ſuch waters as are more than commonly clear and cold. It is not more than one eighth of an inch in length, and in form reſembles the ſmall black leech, except that it is more pointed towards the extremity. The colour of this animal is a beautiful graſs green, and when magnified, it appears to be ſurrounded by a tranſparent edge or border. The eyes are two in number, and of a deep black. Its motions are analogous to the *Hirudo complanata ſtagnalis*, and *octoculata*, but it ſeems to poſſeſs a greater degree of contractile power than any of them.

After being kept for a few days in a glaſs of its native water, it ſeldom fails to appear filled with 5 or 6 ova, which are large in proportion to the animal. Their form oval, and colour brown. Its ſpecific character may be compriſed with ſufficient exactneſs in a few words, viz.

H. viridis oblonga, extremitate acutiuſcula. Dr. Shaw concludes with ſome obſervations on the reproductive power of the ſmaller leeches, which is as great as that of the polypi. His experiments were made in 1773, when theſe animals were divided in all directions, and after being reproduced were again ſubdivided, and again reproduced in a perfect ſtate.

Plate 4, Fig. 1, repreſents the H. viridis both of its natural ſize and magnified.

IX. *The Botanical Hiſtory of the Canella alba.* By Olof Swartz, *M.D. Foreign Member of the Linnean Society.*

AFTER tracing the different notices of this tree, as diſtinguiſhed from, or confounded with, the Winter's bark, from the time of Cluſius to that of Solander, the writer gives the following particular deſcription of it, taken from a number of perfect ſpecimens.

" Canella alba is a tree whoſe ſtem riſes from 10 to 50 feet in height, very ſtraight and upright, and branched only at the top. The bark is whitiſh, by which it is commonly known at firſt ſight in the woods.

The branches are erect, and not ſpreading.

The leaves are petiolated, and grow in an alternate order, but not regularly. They are oblong, pointed at the end, entire in the margin, and without any diſtinct nerves or veins; of a dark green hue, a thick conſiſtence, like thoſe of laurel, and ſhining.

The flowers grow at the tops of the branches in cluſters, but upon divided footſtalks: they are ſmall and ſeldom open, and of a violet colour.

The character of the flowers is as follows, in botanical language, which is the moſt proper and expreſſive.

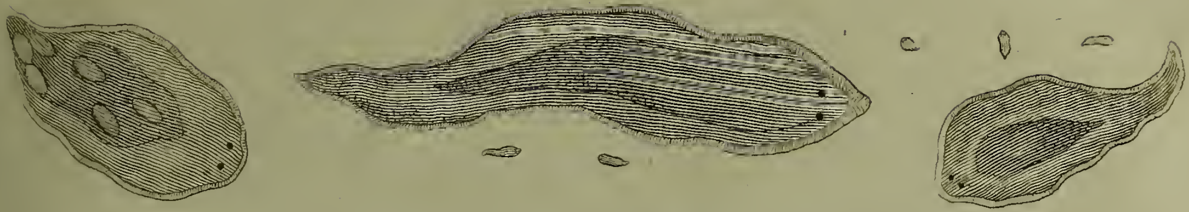
Cal. Perianthium monophyllum 3 lobum.
Lobi ad baſin fere diviſi, ſubrotundi, concavi, incumbentes, virides, glabri, membranacei, perſiſtentes.

Cor. Petala 5 calyce longiora, oblonga, ſeſſilia, concava, erecta, duo paulo anguſtiora, conſiſtentia, decidua.
Nectarium urceolatum, longitudine petalorum, antheriferum, deciduum.

Stam. *Filamenta* nulla.
Antheræ 21 lineares parallelæ, diſtinctæ, longitudinaliter nectario extus adnatæ, univalves.
Pollen luteum.

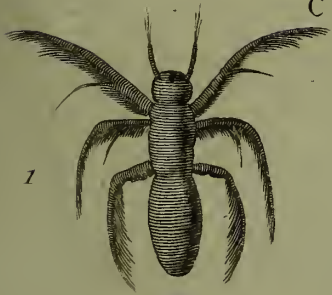
Facing pa: 62. *Plate II.*

HIRUDO VIRIDIS *Fig: 1.*



CANCER STAGNALIS *Fig: 2.*

1



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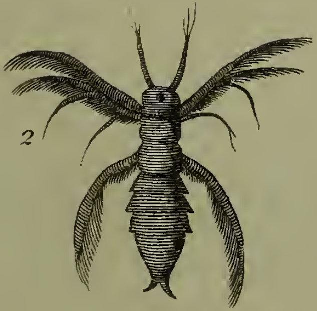

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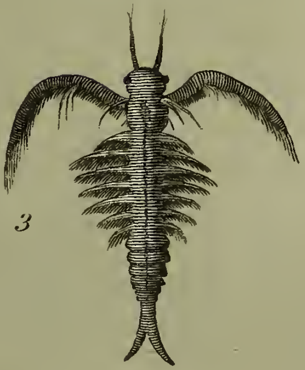

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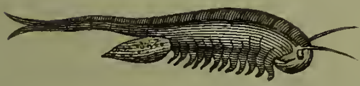

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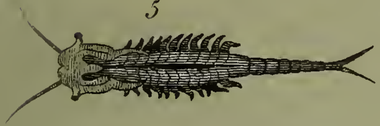

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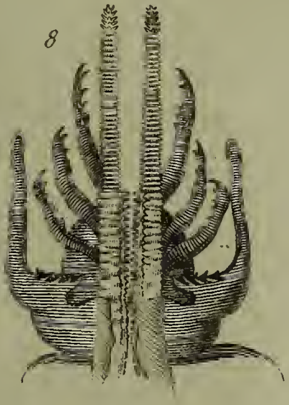
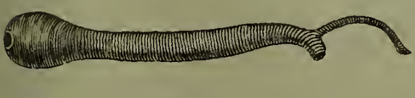


Fig: 3.

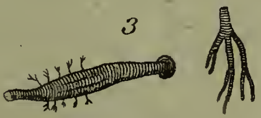
FASCIOLA CLAVATA

2



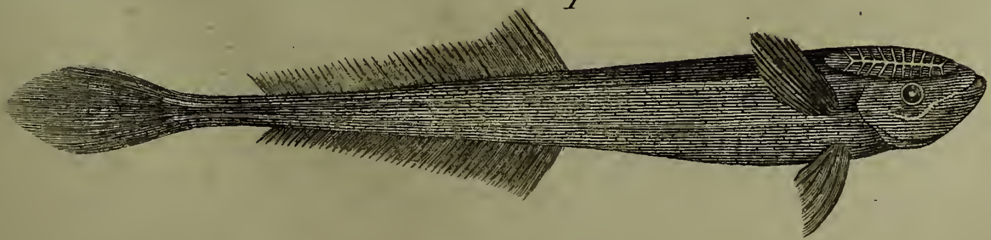
HIRUDO BRANCHIATA.

3



ECHENEIS LINEATA

1



Pist. *Germen* ſuperum, intra nectarium, ovatum.
Stylus cylindricus, longitudine nectarii.
Stigmata duo, obtuſa, convexa, rugoſa.
Per. *Bacca* oblonga unilocularis 2—4 ſperma.
Semina ſubrotundo-reniformia, nauco fragili nitenti tecta.

The diſtinguiſhing marks deduced from this character are,

Calyx trilobus.
Corolla pentapetala.
Antheræ 21, adnatæ nectario urceolato.
Bacca unilocularis, 2—4 ſperma.

This genus, whoſe name is more properly changed to that of Canella, cannot be removed from dodecandria, where it has formerly been, notwithſtanding its flowers bear ſome ſimilarity to thoſe of the ſixteenth claſs. But on the ſame principle, *Melia*, *Trichilia*, *Samyda*, *Erythroxylon*, &c. ſhould alſo change their place, which ſeems not very juſt, as they cannot be ranged among the Columniferæ, the natural tribe of that claſs.

There are various figures given of this plant by ſeveral authors; as by Plukenet, in the *Phytogr.* tab. 160, f. 1; by Sloane, in the *Hiſtory of Jamaica*, vol. ii. tab. 191, f. 2, and in the *Philoſophical Tranſact.* 1692, No. 192; by Catesby, in his *Hiſtory of Carolina*, vol. ii. p. 50, tab. 50; by Mrs. Blackwell, in her *Icon*, tab. 206; and, laſtly, by Browne, in his *Natural Hiſtory of Jamaica*, tab. 27, f. 2. The laſt is the only tolerable one among them all; but it ſeems ſo little underſtood by Browne himſelf, that he has referred Breynia fruticoſa, fol. ſingularibus oblongo-ovatis ſuperne nitidis, &c. *Hiſt. of Jam.* p. 246, n. 3, to this figure, evidently that of the *Canella alba*, of whoſe parts of fructification he has annexed another drawing on the ſame plate (fig. 3), though leſs accurate and diſtinguiſhable.

The tree is pretty common in moſt parts of the Weſt-India Iſlands, and is frequently found near the ſea-coaſt, but then ſeldom exceeding 12 or 15 feet: in the inland woods it attains a more conſiderable height.

The whole tree is very aromatic, and when in bloſſom perfumes the whole neighbourhood. The flowers dried, and ſoftened again in warm water, have a fragrant odour, nearly approaching to that of muſk. The leaves have a ſtrong ſmell of laurel. The berries, after having been ſome time green, turn blue, and become at laſt of a black gloſſy colour, and have a faint aromatic taſte and ſmell. They are when ripe, as well as the fruit of ſeveral kinds of laurel, very agreeable to the *White-bellied and Bald-pate Pigeons (Columba Jamaicenſis & leucocephala)*, which feeding greedily upon them, acquire that peculiar flavour ſo much admired in the places where they are found.

This bark, together with the fruit of Capſicum, were formerly common ingredients in the food and drink of the Caraibs, the ancient natives of the Antilles; and even at preſent it makes a neceſſary addition to the meagre pot of the Negroes.

A figure of a branch of the tree in flower, and of the berries, is annexed.

X. *Deſcription of the Cancer ſtagnalis of Linnæus.* *By* GEORGE SHAW, *M.D. F.R.S. Fellow of the Linnean Society.*

"THE Cancer ſtagnalis of Linnæus being certainly one of the moſt curious animals of the genus to which it belongs, and being not yet ſo generally known as the reſt of the Britiſh ſpecies; I hope the following obſervations, which I have had frequent opportunities of making on this inſect, and particularly thoſe which relate to its infant ſtate, or firſt appearance from the egg, may be not unacceptable to the Linnean Society.

The Cancer ſtagnalis is generally found in ſuch waters as are of a ſoft nature, and particularly in thoſe ſmall ſhallows of rain-water which are ſo frequently ſeen in the ſpring and autumn, and in which the Monoculus Pulex of Linnæus, and other ſmaller animalcula abound. At firſt view this inſect bears ſome reſemblance to the inſect which ſome writers have called Squilla aquatica, or the larva of a Dytiſcus; but when viewed nearly it is found to be of a much more curious and elegant appearance than that animal. The legs, of which there are ſeveral pair (eleven) on each ſide, are flat and filmy, and have the appearance of ſo many waving fins, of the moſt delicate ſtructure imaginable. The whole animal is extremely tranſparent, and the general colour of the males is a very light brown, with a tinge of blueiſh green, particularly on the head and legs. The females have leſs of the blueiſh tinge, and decline more to brown, except on the ſpine of the back, which is of a deep dull blue, and which part in the male is of a deeper brown than the reſt of the body. The head of the male is armed with two fangs of a very ſtrong appearance, and which end in two long hooks bending inwards; and between the fangs lies a very curious apparatus, which will be more particularly deſcribed hereafter. The eyes are very protuberant, and, as it were, furniſhed with a ſtalk, as in the reſt of the genus Cancer. The female is deſtitute of the two long fangs which are ſo conſpicuous in the male, and, inſtead of them, is only furniſhed with a ſtrong, thick, ſhort pair of forceps: but what principally and immediately diſtinguiſhes the female, is a large, oval, ſharp-pointed bag of ova, which is ſituated underneath the lower part of the body where the tail commences. It is remarkable that the ſmaller ſized females are frequently furniſhed with this bag of ova, as well as the larger ones. The tail, which is perfectly alike in both ſexes, is of a red colour, more or leſs deep, from the middle to the very end, which is forked into two very ſharp points. Theſe creatures ſhould ſeem by their appearance to be of a predaceous nature, and I have no doubt that they really are ſo; the ſtructure of their fangs ſeeming to be particularly adapted to the purpoſe of ſeizing their prey: yet I never obſerved thoſe which I kept, to attack any of the animalcules which were in the ſame water: on the contrary, the Monoculus conchaceus very frequently aſſaults them, and adheres with ſuch force to their tails, or legs, as ſometimes to tear off a part in the ſtruggle. The C. ſtagnalis delights much in ſunſhine, during which it appears near the ſurface of the water, ſwimming on its back, and moving in various directions by the ſucceſſive undulations of its numerous fin-like legs, and moving its tail in the manner of a rudder. On the leaſt diſturbance, it ſtarts in the manner of a ſmall fiſh, and endeavours to ſecrete itſelf by diving into the ſoft mud. It changes its ſkin at certain periods, as is evident from the exuviæ or ſloughs being frequently found in the water in which theſe animals are kept.

In March and April the females depoſit their eggs, without any ſettled order, and perfectly looſe in the water. They appear to the naked eye like very minute globules of a light brown colour; ſcarce, if at all, exceeding in ſize the particles of the farina in a mallow: and what makes this compariſon the more juſt, is, that each ovum, when magnified, is extremely like one of the globules of farina in that plant; for it is thickly beſet on every ſide with ſharp ſpines, the length of which is equal to about the fourth part of the diameter of the egg. Beſides theſe ſpines, the egg is coated over with a tranſparent ſubſtance, reaching juſt to the extremities of the ſpines.

This is a particularity of ſtructure which I do not remember to have obſerved in the ovum of any other inſect; and may probably be intended to aſſiſt in cauſing them to adhere to the ſubſtances on which they fall when depoſited in the water, or elſe as a ſecurity from the ſmaller water-inſects.

In the ſpace of a fortnight, or in cold weather rather more, they are hatched; and the young animals may be ſeen to ſwim with great livelineſs by means of three very long pairs of arms, or rowers, which appear diſproportioned to the ſize of the animal: and indeed it bears, in this very ſmall ſtate, not much reſemblance to the form which it afterwards aſſumes; but, in the ſhort ſpace of a very few hours, the body appears conſiderably lengthened, and it begins to acquire the remarkable character of the divided tail fin, which ſo ſtrikingly diſtinguiſhes the parent animal. In this very young ſtate the eyes do not appear pedunculated, but like a dark ſpot on the middle of the head.

On the ſeventh day after hatching, they approach pretty nearly to the form of the complete animal, except that they ſtill retain the two firſt or long pairs of rowers or arms: the legs however, or fins, are at this period very viſible. After this time it loſes the long rowers, and appears ſtill more like the inſect in its advanced ſtate. Its growth, however, is but ſlow; and in all probability a very conſiderable time elapſes before the inſect acquires its full ſize: but this I cannot preſume to determine, ſince thoſe which were hatched in the glaſſes in which I kept them, died before they had acquired any conſiderable ſize.

In order to obtain theſe inſects in a young ſtate, nothing more is required than to keep the females ſelected for this purpoſe in ſeparate glaſſes of the ſame water in which they naturally reſided. The glaſſes ſhould be ſmall; and, when the eggs are depoſited, the parent inſects muſt be removed, and the glaſſes kept in a temperate room.

When firſt hatched, they are very little ſuperior in ſize to a common mite.

The three microſcopic views of the young animals were drawn with the greateſt attention, and their accuracy may be ſafely depended upon.

Plate 4, Fig. 2, No. 1, Shews the young inſect very ſoon after hatching.

No. 2. Repreſents it ſome hours after, at which time the forking of the tail is juſt viſible, as well as the ſegments of the body; whereas, in No. 1, the body has not yet lengthened itſelf ſufficiently to ſhew the joints of which it conſiſts, or the forking of the tail.

No. 3. Shews it on the ſeventh day after hatching.

It is remarkable that the Cancer ſtagnalis, in its complete ſtate, though of the moſt delicate ſtructure, is yet capable of ſupporting a very conſiderable degree of cold, as is evident from the animal making its appearance in the middle of the day in very ſhallow waters, which have been almoſt entirely frozen during the night. Yet Schæffer repreſents thoſe which he found to be exceedingly impatient of cold; and adds that he has known a whole race of them completely killed in their native water by a very ſlight froſt. This is certainly not the caſe in our own country. I have ſeen great numbers of them in the months of December and January, even immediately before and after intenſe froſts, ſeemingly as vigorous and lively as in the ſpring and ſummer: they muſt therefore either plunge themſelves to ſuch a depth in the ſoft mud as to be ſecure from the froſt, or elſe they are not injured by being frozen for a time.

An exact *microſcopic deſcription* of the inſect follows, which we do not think it neceſſary to copy, as the figures ſo well explain themſelves.

Explanation of Fig. 2, in Plate 4. No. 1, 2, 3. Cancer ſtagnalis in a young ſtate magnified. 4. The perfect inſect, female, natural ſize. 5. Ditto, male. 6. Eggs. 7. An egg magnified. 8. The apparatus of the mouth.

XI. *On the Feſtuca ſpadicea, and Anthoxanthum paniculatum, of Linnæus. By* JAMES EDWARD SMITH, *M.D. F.R.S. Preſident of the Linnean Society.*

A GRASS which Linnæus admitted into his Sp. Plant. under the name of *Anthoxanthum paniculatum*, and which occaſioned much perplexity to botaniſts, is traced by the Preſident through various authors, and its ſpecific character and ſynonyms thus given.

FESTUCA paniculâ erectâ, ſpiculis ovatis quadrifloris, glumis acuminatis muticis, foliis ſetaceis glabris pungentibus.

POA paniculâ erectâ, ſpiculis trifloris glabris, corollis acuminatis, calyce duplo longioribus. *Ger. Gallo. prov.* 91, tab. 2, f. 1.

POA culmo recto, locuſtis trifloris glaberrimis, calycibus ariſtatis. *Hall. Hiſt.* V. 2, 223, No. 1463.

POA Gerardi. *Allion. Flor. Pedemont.* V. 2, 245, No. 2201.

ANTHOXANTHUM (paniculatum) floribus paniculatis. *Linn. Sp. Pl.* 40, *Am. Acad.* 1. 145.

GRAMEN ſparteum, paniculâ flaveſcente. *Rudb. Elyſ.* V. 1, 40, f. 14.

Habitat in pratis et paſcuis alpinis. ♃

An exact deſcription is ſubjoined; and the Preſident obſerves, that he has lately learned from Savoy that this graſs is likely to become of conſiderable uſe in agriculture, and that large quantities of it are now cultivating. It has vegetated in Chelſea garden from the ſeed he brought from Mount Cenis.

In Additional Remarks, read October 5, 1790, the writer eſtabliſhes the identity of this graſs with the *Feſtuca ſpadicea* of Gouan's Illuſtr. Botan. and Linnæus's Syſt. Naturæ. ed 12. He alſo adds the following ſynomyms from the Sherardian Herbarium.

Gramen paniculatum, alpinum, radice craſſiſſimâ, foliis rigidis, ſtriatis, et aſperis, paniculâ fuſcâ non ariſtatâ. *Michelii Hort. Piſan.* 75.

G. montanum paniculâ ſpadiceâ craſſiore. *Tournef. Inſ.* 524.

Nardus ſpuria Narbonenſis. *C. Bauh. Pin.* 13.

Nardus Gangitis ſpuria Narbonæ. *Lob. Adverſar.* 43.

The errors of Linnæus in applying the above ſynonyma are remarked upon. A copy of Rudbeck's figure from his Campi Elyſii is given in the Tranſactions.

XII. *On*

XII. *On the Migration of certain Birds, and on other Matters relating to the feathered Tribes.* *By* William Markwick, *Eſq. Aſſociate of the Linnean Society.*

THE facts contained in this paper are all from the perſonal obſervation of the author, whoſe reſidence is at Catsfield, near Battle in Suſſex, about five miles from the ſea ſide.

He gives firſt a *ſynoptical table* of the appearance and diſappearance of a number of birds for ſixteen years, from 1768 to 1783; to which are ſubjoined *Explanatory Remarks.* Theſe, as containing the principal reſults of the table, with various curious particulars, we ſhall copy for our readers.

" Hirundo ruſtica---*the Swallow.* The Swallow's firſt appearance was generally about the 12th of April, never earlier than the 7th, or later than the 27th of that month; and I never ſaw it later in the year than the 16th of November, and then only a ſingle bird or two, the generality of them diſappearing long before that time.

" Hirundo urbica---*the Martin.* This bird is ſomewhat later in its appearance than the foregoing one, we having never ſeen it earlier than the 17th of April; but in general it does not appear till toward the latter end of that month, and frequently not till May, having one year not been ſeen till the 12th of May; and I never ſaw it later in the year than the 13th of November; but, like the former, the generality had diſappeared before.

" Hirundo Apus---*the Swift.* This bird is later in its appearance than either of the two former ones, being hardly ever ſeen before the beginning of May, twice only on the 28th and 29th of April during the whole ſixteen years; and its lateſt appearance was on the 18th of May; nor does it remain ſo late in the autumn as the former ones, the lateſt I have ever obſerved it being the 2d of September.

" Hirundo riparia---*the Sand Martin.* As this bird is not near ſo common in this country as the other ſpecies, my obſervations on its appearance muſt be uncertain, though I believe it generally makes its appearance very early, as I once obſerved it on the 8th, and another year on the 10th of April; but ſometimes, indeed, I did not ſee it till late in the year, owing, I ſuppoſe, to their being ſcarce. The lateſt I ever ſaw it in the autumn was the 25th of September.

" Jynx Torquilla---*the Wry Neck.* The firſt appearance of the Wry Neck for ſixteen years together was generally about the 13th of April, never earlier than the 26th of March, nor later than the 25th of April; and the lateſt of its continuing to appear was the 14th of September.

" Cuculus canorus---*the Cuckoo.* The firſt of the Cuckoo's being heard for ſixteen years together was generally about the latter end of April, never earlier than the 17th of that month, nor later than the 5th of May; and it continues to ſing till about the latter end of June, the 26th being the lateſt that I ever heard it. After that it is ſilent, though it continues to make its appearance till the beginning of September, the 14th of that month being the lateſt period of my ſeeing it. What Willughby and others aſſert concerning this bird's breeding in the neſt of a ſmall bird, I know to be a fact, having myſelf taken a young Cuckoo out of the neſt of an hedge-ſparrow, and kept it in a cage till the approach of winter, when it died.

" Caprimulgus Europæus---*the Goat Sucker.* I have only taken notice of ſeeing this bird in the year 1781, on the 29th of May.

" Columba Turtur---*the Turtle.* I have only taken notice of the appearance of this bird in two years, 1781 and 1782, which was on the 4th and 11th of June.

" Scolopax Ruſticola---*the Woodcock.* The firſt appearance of the Woodcock, according to my journal during ſixteen years, has been generally in October, never earlier than the 12th of that month; and as to its continuance with us, I never ſaw it later than the 10th of April. We have had two or three inſtances, in this neighbourhood, of young Woodcocks being ſhot in the ſummer-time; and I think I once ſaw an egg of this bird taken out of a neſt in the neighbourhood: but their breeding here is very uncommon, and owing, I ſuppoſe, to accident; the old ones perhaps having been wounded by ſportſmen in the winter, and ſo diſabled from taking a long journey in the ſpring.

" Scolopax Gallinago---*the Snipe.* This bird alſo generally makes its firſt appearance in October: I once ſaw it ſo early as the 29th of September, and the 14th of April was the laſt of my ſeeing it here.

" Scolopax Gallinula---*the Jack Snipe.* This bird is not ſo frequently met with as the foregoing, ſo that I cannot ſpeak with certainty as to its appearance; though I believe it is ſome time later than the common Snipe, the earlieſt of my ſeeing it being the 20th of November, generally not before December; though it ſeems to continue with us late, as I have ſeen it on the 19th of April.

" Corvus Cornix---*the Royſton Crow.* This bird, being ſeldom ſeen far from the ſea-coaſt, has not been very frequently obſerved by me. The earlieſt of its appearance, according to my journals, was the 17th of October; and I never ſaw it after the 14th of April, that being the lateſt of my obſerving it, according to my notes.

" Turdus pilaris---*the Fieldfare.* This bird is very uncertain in its appearance. Some years great flocks of them are early to be ſeen; other years very few, and thoſe not till late in the winter: which variation, as to the time of their appearing, is cauſed, as I ſuppoſe, by the different degrees of cold in the different winters. The earlieſt appearance of this bird that I have obſerved, was on the 26th of October, and the lateſt of my ſeeing it was the 8th of April.

" Turdus iliacus---*the Red Wing.* This bird is alſo very uncertain as to the time of its firſt appearance, but ſeems to be later in its viſits than the foregoing; for, according to my journal, the 14th of December is the earlieſt of its appearance, and in general I did not ſee it till January or February. In March and the beginning of April, when the weather is fine, the Red Wings aſſemble together on the tops of high trees, and ſing very melodiouſly; ſoon after which they leave us, the 13th of April being the lateſt of my ſeeing theſe birds.

" Rallus Crex---*the Land Rail.* The firſt appearance of this bird I cannot ſpeak to with any great certainty, having ſeldom met with it before the ſeaſon for ſhooting Partridges, September; though it has twice made its appearance in Auguſt, once on the 24th, and the other time on the 27th. And how long it continues with us is alſo uncertain; though I do not recollect ever to have ſeen it ſo late in the year as November. That it is a bird of paſſage, and that its ſtay with us is ſhort, is moſt probable; for it does not breed here, and certainly leaves us before the winter commences. From its generally flying very ſlow, and to all appearance weakly, one would ſuppoſe it ill adapted to long and quick flight: but that it can exert itſelf on occaſion, I have been an eye witneſs; having ſeen it fly with amazing ſwiftneſs, equal to that of any Hawk: it alſo runs very faſt.

" Fringilla Spinus---*the Siſkin, or Aberdavine.* This little bird was obſerved only in the years 1768, 1769, 1774, 1780 and 1781. It is undoubtedly a bird of paſſage, ſpending a ſhort time with us early in the ſpring, probably in its paſſage from one country to another, as it neither breeds with us in ſummer, nor appears here in the winter. I never ſaw it before the 5th of April, nor after the 30th of the ſame month. I obſerve it feeds on the ſeeds which are in the cones of the fir. With us it is called the Barley-bird, from its appearing about the time of ſowing barley, and continuing with us no longer than the barley-ſowing laſts.

" Mr. Latham ſays it is not unfrequent in England in the winter. With us it is ſeldom ſeen at all. I never ſaw it in the winter. The longeſt ſtay I ever obſerved it to make, was from the 10th to the 30th of April in the year 1780.

" Lanius Collurio---*the red-backed Butcher Bird.* This bird breeds with us, and generally appears about the 9th or 10th of May; having never been ſeen by me earlier than the 9th of May, and one year I did not ſee it till the 7th of June.

" Motacilla Phœnicurus---*the Redſtart.* Mot. Trochilus---*Willow Wren.* Mot. Sylvia---*White Throat.* Mot. Oenanthe---*Wheat Ear,* and Mot. Luſcinia---*Nightingale.*

" Theſe ſmall birds generally appear pretty early in April, and continue to make their appearance till September, ſometimes rather later, as I have ſeen the Wheat Ear and Willow Wren in October. The ſame temperature of the air in the ſpring, which invites the flies and other ſmall inſects to come forth, brings theſe birds to feed on them. But whether they come out from their hiding places, as the inſects do, or whether they come from far diſtant countries, is a queſtion not yet determined by naturaliſts. Probably the life of inſects is terminated with the ſummer, and the inſects of the following year are produced from eggs, which are hatched by the warmth of the ſpring: but no naturaliſt ever aſſerted that this was the caſe with birds. Their life is certainly prolonged from year to year; but how they diſpoſe of themſelves during the winter, is the queſtion. I never ſaw theſe birds in the winter, the earlieſt of my ſeeing any of them being on the 13th of March, when I ſaw the Wheat Ear.

" Muſcicapa Griſola---*the Fly Catcher.* Mot. Atricapilla---*Black Cap.* and Mot. Rubetra---*Whin Chat.*

" Theſe birds appear ſomewhat later than the foregoing, but I never ſaw any of them in the winter.

" I will here beg leave to mention a few particulars reſpecting other birds which have engaged my notice: the white Water-wagtail, the grey Water-wagtail, and the yellow Water-wagtail.

" How the Water-wagtails diſpoſe of themſelves in the winter, is the moſt difficult to account for of any birds I know; for though the generality of them diſappear in the autumn, yet they are often ſeen in the middle of winter. If there happens to be a fine day, and the ſun ſhines bright, theſe birds are ſure to make their appearance, chirping briſkly, and ſeemingly delighted with the fine weather: whereas, perhaps, they had not been ſeen for three weeks or a month before. In ſhort they are never ſeen in winter but on a fine day. Where do they come from? Certainly not from a far diſtant country; there not being time for a very long journey in the ſpace of a ſingle day; and beſides, they never ſeem to be tired or lifeleſs, but are very briſk and lively.

" Sterna Hirundo & Sterna minuta---*Sea Swallows.* Theſe birds are, as I ſuppoſe, ſummer birds of paſſage; appearing on our ſea coaſts about April or May, and continuing with us till the autumn. The earlieſt that I have obſerved the great Sea Swallow, Sterna Hirundo, was the 15th of April; the leſſer, or Sterna minuta, the 24th of April; and the black Sea Swallow, Sterna fiſſipes, is ſo rare, that in ſixteen years I obſerved it but once, and that was on the 28th of April.

"As to the time of their leaving us, I cannot ſpeak with any certainty. I once ſaw the leſſer Sea Swallow ſo late as the 15th of October.

"Motacilla Atricapilla---*the Black Cap,* ſings very prettily, and has a note ſomewhat like the Nightingale; for when I firſt heard it, I took it for that bird, till I had ſeen it."

"Charadrius Oedicnemus---*the Stone Curlew,* whiſtles in the evening. I heard this bird June 17th, 1770, amongſt the corn on the downs not far from Eaſtbourn, where I ſuppoſe it breeds.

"Corvus Corax---*the Raven.* There ſeems a wonderful antipathy between this bird and the Corvus frugilegus, or Rook. In the year 1778, as ſoon as a Raven had built her neſt in a tree adjoining to a very numerous rookery, all the Rooks immediately forſook the ſpot, and have not returned to build there ſince.

"At the Biſhop of Chicheſter's rookery at Broomham near Haſtings in Suſſex, upon a Raven's building her neſt in one of the trees, all the Rooks forſook the ſpot; but they returned to their haunt in the autumn following, and built neſts there the ſucceeding year. When this circumſtance took place, the good Biſhop was very ill. The flight of the Rooks (for at firſt the cauſe of it was not known) was conſidered by the country people as ominouſly portending the death of the poſſeſſor. However, his Lordſhip happily recovered; and, in the mean time, the flight of theſe poor prophets was better accounted for.

"Motacilla Regulus---*the golden-crowned Wren.* This bird though the ſmalleſt of any except the humming-bird, and to appearance the moſt delicate, is yet hardy enough to endure the cold of our ſevereſt winters; for it is now (January 26th, 1776) the ſevereſt weather I ever remember, and yet it is chirping before me.

"Before I conclude this article, I will beg leave to mention a few birds found in my neighbourhood, which are rarely met with. And I do this the more readily, as I am deſirous of affording evidence of the ſouthern ſituations in which they have been taken. They are the Scolopax lapponica, *the ſmall Curlew,* or *red-breaſted Godwit*; the Tringa Glareola, or *brown-ſpotted Sandpiper*; the Ampelis garrulus, or *Chatterer*; and the Fringilla Montifringilla, or *Brambling.*"

The *Tringa Glareola* having never been figured by any author, Mr. Markwick gives a drawing of it, with a particular deſcription. It is the *Wood Sandpiper* of Latham's Synopſis.

XIII. *The Hiſtory and Diſcription of a new Species of Fucus.* By Thomas Woodward, *Eſq. Fellow of the Linnean Society.*

A Plant of the order of Algæ has been long found in great quantities waſhed upon the ſea-beach at Yarmouth, which appeared to be a non-deſcript. Its place of growth was alſo unknown, till in 1787, Mr. Woodward, viſiting Cromer in

Norfolk, found it growing in plenty among the agglutinated ſtones, which form the beach there. In the following winter, he received from Mr. Wigg of Yarmouth, a ſpecimen of it in a ſtate of fructification, which has enabled him to deſcribe it. He gives the following ſpecific character of it.

Fucus (ſubfuſcus) fronde filiformi, ramoſiſſima, ramis ramuliſque ſparſis, foliis ſubulatis ſubalternis, fructificationibus paniculatis, capſulis ſuboctoſpermis.

Place in the genus, next to Fucus ſiliquoſus.

Hab. Cromer on the coaſt of Norfolk. Duration ⊙ ?

XIV. *Account of a ſingular Conformation in the Wings of ſome Species of Moths.* *By* Mr. ESPRIT GIORNA, *of Turin, Foreign Member of the Linnean Society.*

THIS paper (written in French) begins with ſome general remarks on the yet imperfect ſtate of Entomology. The author then proceeds to expreſs his ſurpriſe that certain parts ſufficiently diſtinguiſhable in the wings of the Sphynxes and Phalenæ, ſhould have remained unnoticed. Of theſe he gives the following deſcription. From the baſe of the lower wing proceeds a point towards its anterior part, more or leſs long, according to the ſize of the inſect, of a cruſtaceous nature, hard, elaſtic and reſiſting, the purpoſe of which is to retain the upper wing in its place; for which reaſon he calls it a *ſpring* or *fulcrum.* It makes with the lower wing an angle of from 15 to 30 degrees. There is beſides a contrivance of a ſort of ring attached to the principal rib of the upper wing, which holds down the ſpring, allowing it free action. This ſecond part only belongs to the males; in the females its place is ſupplied by a bundle of ſmall threads united together.

After this deſcription, illuſtrated by figures, the writer gives a liſt of thoſe ſpecies of Sphynx and Phalæna in which he had obſerved this apparatus in one or both ſexes, with the length of the ſpring and number of the filaments in ſome inſtances. He concludes with ſuggeſting, whether theſe parts might not be uſefully reſorted to in claſſifying inſects, or at leaſt in diſtinguiſhing the ſexes.

To this paper is annexed the following *note.*

"This curious apparatus affixed to the wings of Moths, which Mr. Giorna conſiders as a new diſcovery, has been long known to many of the Engliſh collectors of Butterflies and Moths: it is claimed (and a good account given of it with accurate figures) by Mr. Moſes Harris, in a work of his, entitled, *An Eſſay preceding a Supplement to the Aurelian, wherein are conſidered the Tendons and Membranes of the wings of Butterflies, &c.* In this work the uſe and actions of theſe ſprings appear to be well defined and explained; and Mr. Harris obſerves that it pertains only to the males, the females having, inſtead of the ſprings, four ſmall hairs or briſtles. It was thought, however, proper to publiſh this account, as Mr. Giorna has carried the matter further than Mr. Harris, and it is hoped will excite others to purſue the ſubject."

XV. *Obſervations on the Language of Botany. By the Rev.* Thomas Martyn, *B.D. F.R.S. Profeſſor of Botany in the Univerſity of Cambridge, and Fellow of the Linnean Society.*

THE two fundamental principles of Botanical language laid down by this writer, are, "1ſt. that we ſhould adhere as cloſely as poſſible to the Linnean language itſelf. 2d. that we ſhould adapt the terminations, plurals, compounds and derivatives, to the ſtructure and genius of our ſterling Engliſh." By following the firſt rule, the advantage of an univerſal language is gained, and with no more difficulty than if terms were invented for the peculiar uſe of each national language. Yet it admits of this exception; that where a ſignificant Engliſh term has been in long and general uſe, it ought to be preferred. Thus it would be abſurd to ſubſtitute *folium* for *leaf*, or *ſemen* for *ſeed*. Alſo, when an eaſy compound word in Engliſh can be formed, inſtead of a ſeſquipedalian Latin one, it may be preferable; as *funnel-ſhaped* rather than *infundibuliform*; and the like. The uſe of the ſecond rule is manifeſt to give more regularity to our language, and avoid the barbariſms which diſgrace it beyond almoſt any other. Thus Latin terminations in *a*, *us* and *um* which are foreign to the original nature of our language, ſhould if poſſible be dropt for more analogical ones; and *nectary* may be uſed for *nectarium*; *ſtyle*, for *ſtylus*; *glume* for *gluma*, &c. The Engliſh plural in *s* ſhould alſo be always employed inſtead of thoſe of the Latin declenſions. Other ſimilar obſervations are added; but the writer means rather to ſuggeſt general hints than to exhauſt his ſubject.

XVI. *Obſervations on the Genus of Begonia. By* Jonas Dryander, *M. A. Libr. R. S. and Member of the R. Acad. of Sciences of Stockholm, Fellow of the Linnean Society.*

THE genus Begonia, firſt eſtabliſhed by Plumier, and publiſhed in 1700 by Tournefort, has been ſince ranged by different botaniſts very differently, and is termed by Juſſieu "Genus nulli verè affine." Its ſpecies have likewiſe been very imperfectly eſtabliſhed. One of them having flowered in October 1788, in Mr. Lee's garden at Hammerſmith, Mr. Dryander was induced to ſtudy the genus Begonia for the purpoſe of determining that plant; and having an opportunity of comparing dried ſpecimens of ſeveral ſpecies, and the aſſiſtance of deſcriptions of ſome by Drs. Solander and Kœnig, together with the knowledge to be gained from printed books, he was induced to lay before the Society the reſult of his reſearches. He offers it only as a ſketch of the imperfect knowledge we have of this genus, the variations of which in the parts of fructification are ſo great, that he ſeems to think it might be convenient to divide it into ſeveral artificial ones.

The following is his character of the genus.

BEGONIA. *Tourn. Inſt.* 660. tab. 442. *Lin. Gen. Pl.* ed. i. n. 901. ed. vi. n. 1156. *Ludw. Def. Gen.* 1737. p. 49. 1747. n. 1044. 1760. n. 1266. *Adanſ. Fam.* p. 244. *Lam. Encycl.* i. p. 393. *Gærtn. Sem.* p. 156, tab. 31. *Juſſ. Gen.* p. 436.

(Dixit Plumier in memoriam D. Begon, Regi Galliæ ab intimis conſiliis et rei nauticæ præfecti in ora Santonum, cujus merita in rem herbariam me quidem latent.)

Maſculi Flores.

Cal. nullus.

Cor. *Petala* quatuor (in *octopetala* 6---9): quorum duo oppoſita majora, plerumque ſubrotunda (in *ferruginea* omnia ſubæqualia oblonga).

Stam. *Filamenta* numeroſa (15---100), receptaculo inſerta, breviſſima, interdum baſi coalita. *Antheræ* oblongæ, erectæ.

* *Feminei Flores,* plerumque in eodem cum maſculis pedunculo communi.

Cal. nullus.

Cor. *Petala* plurimis quinque, aliis (4, 7, 18, 19, 21) ſex, aliis (8, 16) fortè quatuor, plerumque inæqualia.

Pist. *Germen* inferum, triquetrum, in plurimis alatum. *Styli* pleriſque tres, bifidi. *Stigmata* ſex.

Per. *Capſula* pleriſque triquetra, alata, trilocularis, baſi ſecus alas dehiſcens; aliis (5, 6) bilocularis; aliis (4, 18) fortè unilocularis.

Character Eſſentialis.

Masc. *Calyx* nullus. *Corolla* polypetala. *Stamina* numeroſa.

Fem. *Calyx* nullus. *Corolla* polypetala, ſupera. *Capſula* alata, polyſperma.

Habitus Generis.

Tota planta carnoſa,
Caulis pleriſque herbaceus, ſed ſpecies quædam acaules.
Folia petiolata, in cauleſcentibus alterna.
Stipulæ ad baſin petiolorum binæ.
Pedunculi pleriſque dichotomi, in cauleſcentibus axillares.

Locus Natalis.

Inter tropicos, in Aſia et America. In Africæ continente nulla ſpecies hucuſque inventa, ſed in inſulis adjacentibus tres.

He then gives the ſpecific character, ſynonyms, and in ſeveral inſtances the deſcription, of twenty one ſpecies, illuſtrated by ſome plates; and adds a liſt of eight obſcure or miſtaken ſpecies.

XVII. *On the Genus of Symplocos, comprehending Hopea, Alſtonia, and Ciponima. By Mr.* Charles Louis L'Heritier, *of the Academy of Sciences at Paris, Foreign Member of the Linnean Society.*

THE writer has no doubt of the propriety of refering theſe four genera to that of Symplocos, and wiſhes he were as certain with reſpect to the claſs and ſpecies. He thus characteriſes the genus.

SYMPLOCOS. *Character eſſentialis.* Calyx ſuperus, quinquepartitus, Petala 5---10, baſi coalita. Ordines plures filamentorum corollæ adnati. Germen inferum. Drupa nuce tri-quinqueloculari.

Character naturalis. Cal. Perianthium ſuperum, campanulatum, quinquepartitum: laciniis ſubrotundo-ovatis, concavis, villoſis, perſiſtentibus.

Cor. quaſi monopetala, campanulata, calyce longior, receptaculo inſerta petalis ſ. laciniis 5---10, ovatis, integerrimis, reflexis, baſi in tubum longitudine calycis coalitis, ſimul deciduis.

Stam. filamenta numeroſa, ſubmonadelpha, ſ. baſi inæqualiter connexa, linearia, plana, erectæ, tubo corollæ adnexa vixque breviora, in plures ordines imbricata; exterioribus ſenſim longioribus latioribuſque. Antheræ ſubrotundæ, biloculares, erectæ.

Pist. Germen inferum, turbinatum, apice ſubemerſum. Stylus filiformis, longitudine ſtaminum. Stigma capitatum, ſubquinquelobum.

Per. Drupa oblonga, oleæformis, unilocularis, calyce coronata.

Sem. Nux ejuſdem formæ, ſtriata, tri-quinquelocularis: nucleis teretibus oblongis.

Car. Linnæus nomine primus Hopeam et Symplocon inter Polyadelphas, Aubletius Ciponimam et Linnæus ſecundus Alſtoniam in Polyandria, collocavere. E characteribus genuinis ſupra deductis patet has omnes ad Monadelphiam et in unum genus revocandas eſſe. Symplocos, utpote antiquius, erit nomen genericum. Locum ordinis vindicat Symplocos hinc inter Gordoniam et Camelliam quibus germen eſt ſuperum, inde inter Guſtaviam et Carolineam quæ gaudent germine infero.

The Species he deſcribes are S. Martinicenſis, S. Ciponima. S. Arechea. S. Tinctoria. S. Alſtonia.

XVIII. *On the Genus of Calligonum, comprehending Pterococcus and Pallaſia. By the ſame.*

TOURNEFORT in his travels in Armenia had diſcovered a new ſhrub, to which he gave the name of *Polygonoides Orientale Ephedræ facie.* From this Linnæus eſtabliſhed his genus of *Calligonum.* Another plant of this genus was diſcovered in the neighbourhood of the Caſpian ſea, by Pallas, who not attending to preceding botaniſts, made it a ſpecies of a new genus, under the name of *Pterococcus aphyllus.* In a ſubſequent volume he aſſerted it to be the ſame with the Polygonoides of Tournefort. To this plant, Linnæus the younger gave the name of its diſcoverer, calling it *Pallaſia caſpica.* The preſent writer has reſtored it to the genus Calligonum, and given the following more accurate character of that genus.

CALLIGONUM. *Character eſſentialis.* Cal. quinquepartitus. Cor. nulla. Filamenta circiter 16, baſi ſubcoalita. Germen ſuperum, tetraëdrum. Styli 4. Nux cruſtâ polypterâ S. polychætâ, unilocularis.

Character naturalis. Cal. Perianthium monophyllum, baſi turbinatum, limbo quinquepartitum: laciniis ſubæqualibus, ſubrotundis, patentibus, demum obſolete reflexis, perſiſtentibus, duabus exterioribus paulo minoribus.

Cor. nulla (niſi calycem dicas.)

Stam. Filamenta circiter 16, divergentia, capillaria, inferne ſubincraſſata pubeſcentia, baſique leviter coalitâ germen nectarii inſtar ambientia, marceſcentia. Antheræ ſubrotundæ, biloculares, peltatæ.

Pist. Germen ſuperum, ovatum, tetraëdrum, acuminatum. Styli tres vel ſæpius 4, filiformes, patentes, baſi ſubcoaliti ſeu deſinentes in acumen germinis, filamentis vix breviores. Stigmata tot quot ſtyli, capitata.

Per. nullum (niſi cruſta nucis.)

Sem. Nux corticata: cortice exſucco inſeparabili; oblonga, tetraëdra, tetraptera, unilocularis, evalvis: alis nunc membranaceis longitudinaliter bipartitis dentatis criſpis, nunc ſetoſis; ſetis ramoſis rigidis mollibus: nucleo ejuſdem formæ.

He then deſcribes as ſpecies under this genus, the C. polygonoides, C. comoſum, and C. Pallaſia.

XIX. *Obſervations on Polypodium Oreopteris, accompanied with a Specimen from Scotland. By Mr.* J. Dickson, *Fellow of the Linnean Society.*

THIS plant has been miſtaken by all the Engliſh botaniſts. Mr. Dickſon points out ſome of the moſt remarkable particulars in which it differs from P. Thelypteris, with which it has been confounded.

XX. *Account of a ſpinning Limax, or Slug. By Mr.* Thomas Hoy, *of Gordon Caſtle. A. L. S.*

" IT is well known that ſeveral inſects, ſuch as ſpiders, and the caterpillars of " many ſpecies of moths, can convey themſelves ſafely through the air, without " wings, by means of ſilk lines or threads, ſpun out of their own body; but it has " not been obſerved as far as I know, that any ſpecies, arranged under Linnæus's " claſs of vermes, is poſſeſſed of a ſimilar power of ſelf conveyance." The following inſtance, however, obſerved by the author, proves the fact. In going through a plantation of Scotch firs, he obſerved a ſmall ſnail, or rather ſlug, (Limax) hanging from a branch of one of them, by a ſingle thread or line, attached to its tail. " This thread, at a diſtance of an inch and a half from the animal, was as fine as thoſe of the *Aranea diadema*, but grew thicker as it approached to its body, and at its junction to the tail was broad, and flat, correſponding to the ſize of that part. The ſlug was four feet below the branch, and four feet from the ground, to which it was gradually approaching, at the rate of an inch in about three minutes."

This line ſeemed to be formed from the ſlimy exudation, ſecreted from the pores on its ſurface, and appeared to require ſome exertion in the animal, to keep up the ſupply. This exertion conſiſted in a particular motion of the head, by which the whole animal was made to turn round, and which therefore twiſted the thread.

This ſlug ſeemed to be of a ſpecies between the *Limax agreſtis* and *flavus*. Linn. Its ſpecific character might be,

Limax *(filans) cinereus margine flavo.*

To this paper there is ſubjoined a note by Dr. Shaw, mentioning his having obſerved a ſimilar phenomenon in September, 1776, but which from his not having found it noticed by any other writer, he conſidered as an accidental circumſtance.

XXI. *Deſcriptions of three new Animals found in the Pacific Ocean. By Mr.* Archibald Menzies, *Fellow of the Linnean Society.*

1. ECHENEIS lineata. Plate 4. Fig. 3. No. 1.

E. CAUDA cuneata, ſtriis capitis decem, lineis albis utrinque duobus longitudinalibus.

Habitat in Oceano Pacifico, inter Tropicos, teſtudini adhærens.

The body of this fiſh is about five inches long; ſubulate, ſmooth, and of a dark brown colour; dotted all over with minute darker ſpots, and ornamented with two whitiſh longitudinal lines on each ſide, which begin at the eyes and end in the tail.

The under mandible is a little longer than the upper, and both are furniſhed with minute teeth. The clypeus on the top of the head has but ten tranſverſe ſtreaks, which is the chief diſtinction of this ſpecies.

B 10, P 18, D 33, V 5, A 33, C 14.

2. FASCIOLA clavata. Plate 4. Fig. 3. No. 2.

F. corpore teretiuſculo annulato rugoſo albido poſtice gibboſo.

Habitat in Oceano Pacifico, ſæpius in ventriculo Scombri Pelamidis.

This little animal is about two inches long, having a ſoft cylindrical body annulated with fine wrinkles; and towards the extremity it becomes ſpherically gibboſe, ending in the anal aperture, and ſtrongly marked with tranſverſe *rugæ*. About two thirds of its length from this extremity, the ventral aperture protrudes; from which to the mouth it becomes very ſlender, and on the under ſide ſomewhat depreſſed.

In moving, it faſtens itſelf alternately by the ventral aperture and its mouth, raiſing its ſlender neck between them into an arched form like a leech, and in this manner drags its body along with a ſlow motion.

It is of a whitiſh colour, ſomewhat pellucid, diſcharging at its mouth a black-coloured fluid, which can eaſily be perceived through its body. I have often found it in the maws of the boneto, between the Tropics, in the Pacific Ocean.

3. HIRUDO branchiata. Plate 4. Fig. 3. No. 3.

H. depreſſa attenuata albida, ſetis lateralibus ramoſis utrinque 7, interaneis fuſcis bifidis perlucentibus.

Habitat in Oceano Pacifico, teſtudini adhærens.

The body, when moving, is about an inch long, of a whitiſh pellucid colour, ſoft, depreſſed, annulated with fine rugæ, and towards the head attenuated, having a row of ſoft pellucid branchy briſtles on each ſide, oppoſite to one another, making in all ſeven pair. The head is ſmall and truncated; but the other extremity is larger, round, and dilated. The entrails appear through the body, bifid, and of a dark brown colour.

This ſpecies was found in great abundance adhering to a turtle, in the Pacific Ocean, between the Tropics.

XXII. *Remarks on the Genus Veronica. By the* PRESIDENT.

THE purpoſe of this paper, is to remove the obſcurity which has been thrown upon ſeveral ſpecies of this large genus. It having in many inſtances originated with Linnæus, its removal could only be expected from the inveſtigation of his Herbarium and original manuſcripts. The ſpecies on which his remarks are made, are the *ſpuria*, *officinalis β*, *kamtſchatica*, *alpina*, *multifida*, *latifolia*, *agreſtis*, *arvenſis*, *romana*, *acinifolia*, *peregrina*, and *biloba*. He concludes with deſcriptions of two ſpecies, the *gentianoides* and *filiformis*, from Tournefort's Herbarium.

XXIII. *Deſcriptions of two new Species of Phalæna. By Mr.* LOUIS BOSC, *of Paris, Foreign Member of the Linnean Society.*

THESE are, PYRALIS (tuberculana) alis anticis griſeis fuſco-punctatis margine craſſiori antice trituberculato.

TINEA (Sparrmanella) alis violaceo-nitentibus maculis numeroſis aureis, majori ad marginem tenuiorem.

XXIV. *The Botanical Hiſtory of the Genus Dillenia, with an addition of ſeveral non-deſcript Species.* By CHARLES PETER THUNBERG, *Knight of the Order of Waſa, Profeſſor of Botany and Medicine in the Univerſity of Upſal, Foreign Member of the Linnean Society.*

OF the Genus Dillenia, Linnæus has only conſtituted one ſpecies in his ſyſtem, with which he has confounded one of Rumphius's. M. Thunberg obſerved three new ſpecies in the iſle of Ceylon, ſo that there are now ſix known ſpecies. He premiſes to the deſcription of theſe, the following emendated character of the genus.

CAL. *Perianthium* pentaphyllum: *foliola* obovata, obtuſa, concava, coriacea, intus glabra, extus villoſa, perſiſtentia.

COROLLA pentapetala, decidua. *Petala* obovata, inferne attenuato-anguſtata, obtuſiſſima, tenuiſſime ſubcrenata, concaviuſcula, calyce longiora.

STAM. *Filamenta* ſubnulla, ſed. *Antheræ* numeroſiſſimæ, germinis baſi inſertæ, lineares, aurantiacæ, linea nigra exaratæ calyce breviores *Pollen* flavum.

PIST. *Germen* ſuperum, ovatum. *Styli* plures, erecti, ſimplices, antheris longiores. *Stigmata* ſimplicia. *Fructum* maturum videre non licuit.

The ſpecies are theſe.

1. D. (integra) foliis obovatis obtuſis ſubintegris, pedunculis unifloris.
2. D. (ſpecioſa) foliis oblongis, rotundato-acutis denticulatis, pedunculis unifloris.
3. D. (elliptica) foliis elliptico-ovatis acutis ſerratis, pedunculis unifloris.
4. D. (retuſa) foliis obovatis truncatis ſerratis, pedunculis unifloris.
5. D. (ſerrata) foliis elliptico-ovatis acutis ſerratis, pedunculis trifloris.
6. D. (dentata) foliis ovatis retuſis dentatis, pedunculis trifloris.

XXV. *The Botanical Hiſtory of Trifolium alpeſtre, medium, and pratenſe.* By ADAM AFZELIUS, *M.A. Demonſtrator of Botany in the Univerſity of Upſal, Foreign Member of the Linnean Society.*

THE writer, having been for ten years occupied in preparing a new edition of the *Flora Suecica* of Linnæus, thought himſelf well acquainted with almoſt all the Swediſh plants deſcribed by that author; but upon coming into England he was ſurprized in finding that many of the commoneſt plants in Sweden bear quite different names here. This obliged him to examine whether the Engliſh or Swediſh botaniſts beſt underſtood the names uſed by their maſter, and he found reaſon to conclude that the error was not always on one ſide. Their variance is the leſs ſurprizing, as Linnæus has often miſquoted ſynonymous names from ancient authors, and as his characteriſtics of plants, without the deſcriptions, are too conciſe always to diſtinguiſh them from all others. It is the writer's intention ſucceſſively to communicate his obſervations on caſes of this nature; at preſent he confines himſelf to three ſpecies of Trefoil which have been much confounded with each other and with other ſpecies. He begins with what he calls a *brief*, but which is a very minute, hiſtory of each, tracing them through all the botanical writers, under their names and diſguiſes. He then gives a botanical deſcription of them of his own, with a liſt of all the very numerous ſynonyms under each. We ſhall copy only the ſpecific character.

1. Trifolium *alpeſtre*, ſpicis denſis, corollis ſubæqualibus, ſtipulis ſetaceis divergentibus, foliolis lanceolatis, caulibus ſtrictis ſimpliciſſimis.

2. Trifolium *medium* ſpicis laxis, corollis ſubæqualibus, ſtipulis ſubulatis conniventibus, caulibus flexuoſis ramoſis.

3. Trifolium *pratenſe*, ſpicis denſis, corollis inæqualibus, dentibus calycinis quatuor æqualibus, ſtipulis ariſtatis, caulibus adſcendentibus.

He concludes with a deſcription of circumſtances common to all the three, which are, indeed, very numerous.

XXVI. *An Account of ſeveral Plants preſented to the Linnean Society, at different times, by Mr.* John Fairbairn *and Mr.* Thomas Hoy, *Fellows of the Linnean Society.*

THESE are, Coſtus ſpecioſus. Statice latifolia. Sempervivum ſtellatum. Aſtragalus leucophæus. Mimoſa myrtifolia. Mimoſa ſuaveolens.

XXVII. *Extract from the Minute Book of the Linnean Society.*

MR. Dryander communicated to the Society a ſpecimen of an incomplete *Bupreſtis*, ſent to Sir Joſeph Banks from the committee of warehouſes of the Eaſt India company, on account of the damage it had done by eating through fifteen pieces of muſlin, of eight or ten folds in each piece. It exactly reſembles in every thing but colour the B. canaliculata. *Fabr. Mant.*

Mr. Latham ſent to the Society a drawing of a ſingular Pigeon, with a letter mentioning its being found in a dovehouſe along with another fledged in the uſual manner. Its peculiarity conſiſted in not having a ſingle *complete* feather on its body, each ſingle one being encloſed in a caſe the whole of its length, which appears to have been the ſame cuticular ſubſtance with that covering the end of a new feather at its firſt appearance. In this caſe it was protruded unbroken along with the feather, to the length, in ſome of the quills, of ſix inches. The bird lived above a month after being taken.

The Preſident exhibited ſome deſcriptions in Italian, accompanied with rude drawings, of ſeveral rare plants found near Bologna in 1652, appearing to be an original manuſcript of Zannoni.

Tranſactions of the SOCIETY of the ANTIQUARIES of SCOTLAND, Vol. I. 4to. Edinburgh, 1792.

THIS volume is dedicated to the king. The Tranſactions are preceded by an hiſtorical account of the aſſociation, written by Mr. William Smellie, who obſerves, that the ſpirit of inquiry had been depreſſed, by diſſentions of various kinds in Scotland; until by the Union and other events, the two nations became attached to one family and conſtitution, ſince which the progreſs of the Scots had been rapid. That the reſearches of the Antiquary had not been neglected, but that this purſuit could not receive any adequate gratification without the aid of a public eſtabliſhment. Therefore an aſſociation ſimilar to the Antiquarian Society of London was projected; and in December 1780, the Earl of Buchan conſulted ſeveral gentlemen friendly to the deſign, who forming themſelves into a body proceeded to frame ſtatutes. They next applied to his Majeſty for a charter of incorporation, which was granted May 6th, 1783, declaring the king and his ſucceſſors PATRONS of the Society.

Since the firſt inſtitution of the ſociety, at every meeting ſome paper has been read and ſome donation received, of the latter many remarkably curious, and which already amount to 16000 articles, conſiſting of ancient weapons, dreſſes, charters, coins of all ages and nations, &c. The purſuits of this ſociety are not confined to Antiquities alone, but extend to Natural and Civil Hiſtory.

By the ſtatutes of the ſociety, every candidate for an ordinary member, muſt be recommended by three members, and elected by ballot, two thirds of the members preſent being in his favour. Officers of the ſociety to be elected on St. Andrew's Day. Four Cenſors to be annually choſen to review the papers, which are to form the tranſactions of the ſociety. A council of ſeven tranſact the common buſineſs. The Papers in this Volume are,

An Inquiry into the Origin of the Name of the Scottiſh Nation. By SIR J. FOULIS, *Bart.*

SIR James, after having conteſted Mr. Whittaker's opinion reſpecting the meaning of the derivation of the word Scot from *ſceot*, a ſhield, proceeds to his own conjectures, and ſays, that mankind being early devided into two profeſſions, one lived by agriculture, the other by hunting and the increaſe of their cattle, the latter of which ranging from place to place were in reality *ſcuit* or wanderers, and received that appellation. As the Celtic language extended over a vaſt tract, our author has no doubt but this was the origin of the name of that people whom the Greeks calls Σκυθαι. And that the Roman poet in the line *Quarum plauſtra vagas rite trahunt domos*; tranſlated the word *ſcuit* by *vagas*, and that an old Scot would tranſlate the vagas domos of Horace *Tigh-ſcuit*, in Engliſh Scottiſh houſes. The Greeks turning the word to their own idiom the Σκυθαι were in reality the ſcuit behind the Palus Meotis and the Scuit of Ireland and Caledonia were the Σκυθαι of the remote part of the world. This appellation was an honourable diſtinction. Why the name was loſt in one country and extended in another may have ariſen from the ſubſequent conqueſt of Ireland by the Firlbolgs, and by which the Scuit were reduced to few and narrow bounds, but the Caledonians were defended by their mountains from foreign arms.

Why the Romans do not mention the Scuti, might ariſe from their little knowledge of this iſland, which they did not even know to be ſuch until the time of Veſpaſian.

An Inquiry into the Beverage of the Ancient Caledonians, and other Northern Nations, at their Feaſts; and of their Drinking Veſſels. By the ſame.

THE early inhabitants of the N. W. parts of Scotland drank water or milk, until inventive luxury had made them acquainted with fermented liquors, which they uſed at feſtivals to diſſipate their cares, and which is called by the poets, *the Joy of the Shell.* What the liquor was we are ignorant. Of vines none were planted north of the Alps and Pyrennees till near the third century, we may conclude therefore that the Highlanders in thoſe days had none; nor probably diſtilled liquors, as we find no mention of them before James V. Dram, an ordinary word at this day, evidently proceeds from the manner of firſt receiving ſpirituous liquors, medicinally by dram or ſcruple. Cyder was alſo then unknown.

Sir James ſays he will find out what they uſed as beverage by the language, and aſks what is Gaelic for the latin word *bibo?* The moſt proper word is ol elmi, I drink. In the ancient Gothic *ol* ſignifies ale, and in Iceland it is called ſo to this day, and he concludes both the liquor and name came from the Scandinavians. When they brewed ale themſelves, they gave it a name in their own language and called it *loin*, or proviſion.

Ludſadh is a true Gaelic word to expreſs drinking from the root *lus*, a herb; this Sir James looks on as a proof, that they made this liquor from the infuſion of a herb or plant, which ſome think was the juniper, but our author ſays, by a tradition univerſal in the country of the *Pechts*, (as he ſays they ſhould be called) it was heath. If theſe Pechts made a liquor of heath, the neighbouring mountaineers would ſoon after learn it.

From theſe liquors they made another of a more dangerous ſort, by mixing them. *Meaſg*, he ſays, ſignifies mixture, now as mixing liquors is the way to get drunk, ſo the ancient Albanich mixing two liquors together would call it when giddy *meaſg*, and afterwards to diſtinguiſh the effects of this mixture they changed the word to *meiſg* or *meiſge*, which now means drunkenneſs, from whence the word *meiſgach*, a drunkard.

Of the utenſils uſed to convey the liquor to the lip, Sir James ſays the poems mention three *ſlioga*, *corn*, *fuach*; the ſhell, the horn, the cup; of theſe the horn was the eldeſt. The ſhell was next uſed when people advanced to the ſea ſide. In ſome countries huſks of fruit were uſed, but as the barren mountains of Caledonia would not produce any thing for that purpoſe, the capacious ſhell of the ſcallop found in the contiguous ſeas were ſuited to the appetites of thoſe who uſed them. There is not perhaps a nation in the world that has not uſed the horn for this purpoſe, by ſome in their natural form, by others transformed into various ſhapes by art.

One way they uſed this utenſil was particular, being twiſted to go round the arm and filled with liquor, it was lifted to the lips and drank off at a draught; if any liquor was left it rattled in the horn, and the company called out *corneigh*, that is, the *horn cries*, and the delinquent was obliged to drink *Keltie*, or fill again and drink it out according to the law of the Kelts, for ſo the word Celt ought to be pronounced.

The third veſſel for drinking was the cuach, which we now pronounce *quach*, and from whence the Engliſh word quaff. Being compoſed of ſmall pieces of wood united ſo cloſely as to contain liquids. An invention owing to the leiſure of thoſe who tended the flocks; the ſame cauſe which awaked the paſtural muſe. Sir James has ſeen wood elegantly carved by ſhepherds in the Highlands with a knife, and he poſſeſſes the model of an ancient *calamus* made by a ſhepherd on the mountains between Spain and Portugal.

The cuach, he preſumes, firſt gave the hint for making barrels and caſks of greater capacity, it had two handles called lugs by the Anglo Saxons, and large veſſels containing more than a draught were called *luggie*. They had veſſels with handles called *ouata*, and the name of the veſſel was *otis* or *opatis*, words of the ſame import of *lug* and *luggie*. The firſt mention of the *cuach* he finds in a poem called the "Old Bards wiſh," compoſed about 1500 years ago. The poet ſays he took drink from the river, but alſo ſays there was much joy in the cuach, and that they ſlept ſoundly after, from whence he concludes they had liquor ſo ſtrong that they were obliged to dilute it with water.

Of the League ſaid to have been formed between the Emperor Charlemagne and the King of Scotland.

By the ſame.

IN 1773 two treaties were publiſhed, one denying the other, affirming that the king of Scotland entered into an alliance with the emperor Charlemagne. It is ſaid the king of Scotland ſent his brother William with 4000 men. The name *William*, made Sir James look on the whole as an idle ſtory. William is a contraction of two Saxon words, *guild heame*, i. e. *gilded helm*, an honourable diſtinction. Now, it is improbable, a prince of Scotland ſhould have a Saxon name, and with ſuch name and title, be choſen to ſerve an emperor who warried againſt the Saxons. But on reading Fordun, he concludes the princes name was *Gilmor*, for not underſtanding the name, he calls it firſt *Gelmerus*, then *Gilermus*, *Gilerminus*, and at laſt *Guileilmus*. Later writers have copied him. Fordun in another place, makes a king of France ſpeak of the Scottiſh heroes who ſerved under Charlemagne, and among others, he mentions the *Scoti Gilliemore*. He is convinced from this, that he took his account from proper vouchers, as *Gilmor* was the name or title of the king's brother, *Gille* means a lad, and *Gil-mor* literally ſignifies a great lad, and muſt have been ſpecially applied to the king's ſon, as *Monſieur* is in France, and *Infant* in Spain. Our Highlanders to expreſs their chief add *mor* to the name of their clan, as *Clan Chattan-mor*. And in ſome Iriſh pieces they addreſs their national ſaint by the name of *Gille*. There is ſtill to be found in Scotland, a family of the name of *Mac Gellimor* but by the viciſſitudes of fortune they are reduced to the loweſt rank.

Theſe two treatiſes are ſaid to have been written by Lord Hailes, Lord Elibank, and there is another publiſhed by Dr. Arbuthnot.

There was, Sir James ſays, a native of Britain eſteemed by Charlemagne for his learning, other countries claim the honour of his birth; he had ſeveral names, the moſt common *Alcuinus Albinus*, drop the Latin termination *us*, and there remains literally *Alcuin Albin* a Scotiſh Highlander.

Plan for a Royal Foreſt of Oaks in the Highlands of Scotland. By Mr. John Williams, *Mineral Surveyor.*

THE Highlands, Mr. Williams ſays, may be termed the capital foreſt of Great Britain, the grand magazine for ſhip building timber. There are many thouſand acres in Lochaber, Roſs, Invernefs and Argyle, not far from the ſea, of lands which form a rich ſtool of oak, where moſt luxuriant ſhoots are produced in the ſummer, while the goats are on the hills; but are browſed down by them, in autumn, and other cattle, and if any plant eſcapes them, the Highlander ſtrips off part of the bark, and leaves the young tree to die.

The Weſtern Highlands are particularly convenient for growing large timber, the number of roots and trunks prove, that this part of the Highlands was formerly a vaſt foreſt of oak, of the largeſt and beſt quality, formerly, doubtleſs looked on as nuiſances.

To preſerve theſe trees, the ſtools of oaks muſt be incloſed, the goats baniſhed to the glens behind the hills and mountains, and all cattle kept out for the firſt five or ſix years, after which theſe incloſed woods will be a profitable convenience as a well ſheltered winter paſture, and will continue ſo until the oaks require to be cut for the bark; at the end of eighteen or twenty years, after they are cut, the cattle muſt be turned out for five or ſix years, until the ſaplins are out of danger. But this inconvenience may be mitigated by cutting the woods in rotation.

By the preſent method in the Highlands of cutting down all oaks, except a few ſtandards, a preſent profit is procured, and if followed in the N. W. Highlands, would employ a number of poor inhabitants, but this does not ſecure timber for ſhip building; and Mr. Williams therefore propoſes that inſtead of cutting down the oaks, they ſhould be thinned, leaving the principal plants thick enough to defend each other from the injuries of the weather, and when again grown too thick, thinned again, until they have room enough to advance to full trees.

Proprietors of ſmall fortunes will not fall in with this plan, but ſuch a nobleman as the Duke of Gordon might be induced to practice it, and his woods in Lochaber would in twenty years produce a better income than the whole land does at preſent, and the rents not be diminiſhed; and in ſixty or eighty years the profit would be immenſe. In that caſe the ſhips might be built at Fort William, and the ſame in other places.

Mr. Williams ſuggeſts that the board of "annexed eſtates" ſhould lead the way*, and other perſons ſeeing the advantage would follow their example. This ſubject ſeems to him to deſerve the attention of the Britiſh legiſlature, there being no oak woods in Great Britain to be compared with theſe.

Report upon the preceding Paper. By the late Sir Alexander Dick, *of Preſton Field.*

SIR Alexander think the eſſay for the propagation of oak woods in the Highlands, deſerves the attention of the Society, and the public; and that it ſhould be moved in the Houſe of Commons, and the members for Scotland invited to bring it to maturity: one thouſand acres might be cheaper near water carriage incloſed and planted, and if in a few years this plantation appears flouriſhing, others might be begun. Sir Alexander alſo thinks that, of the 5000 pounds annually allowed for roads and bridges in Scotland, as that buſineſs is nearly finiſhed, 3000 pounds might be appropriated for the purpoſe of theſe incloſures, under the direction of commiſſioners, who ſhould report yearly to the king in council.

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* This paper was read before the annexed eſtates were reſtored.

Account of the Pariſh of Haddington. By the Rev. GEORGE BARCLAY, *of Middleton, one of the Miniſters of that Pariſh.*

HADDINGTON, the county town of Eaſt Lothian, is ſituated in 55 deg. 57 min. N. latitude, 17 miles from Edinburgh, and is the firſt ſtage on the great poſt road from London. The name of this pariſh is evidently Saxon, the greateſt extent is about ſix miles, but in ſome places narrower, the Tyne runs through and divides it into equal parts, it contains about 12000 acres of land, 3915 inhabitants, of which 2055 reſide in the burgh, 512 in the ſuburbs, and the reſt in the country, it was once much larger, but in 1674, part of it was annexed to Athelſtamford, and in 1692 the pariſh of Gladſmuir was formed, and various baronies taken from Haddington for that purpoſe. It was once more populous than it now is, for in 1784, the births on an average of ſeven years amounted to 199, which ſuppoſes a population of 6000 inhabitants. This is to be aſcribed to the engroſſing of ſmall farms, for the town of Haddington has increaſed within theſe forty years.

Haddington is a burgh of great antiquity, but when incorporated is uncertain. It is governed by a provoſt, three bailies, a dean of guild, a treaſurer, eleven merchants or trades councellors and ſeven deacons, elected in October, but uſually continued for two years. The revenues amount to about 400 pounds ſterling, ariſing from the rent of mills, petty cuſtoms, &c. Haddington is the tenth in the order of precedence among the royal burghs. It has two annual fairs, in July and October, and a weekly market, and has long been a ſeat for the Woollen manufactory. In 1244 it was conſumed by fire. In 1358 it was almoſt deſtroyed by an inundation. In 1548 Lord Grey fortified it, and ravaged the whole country round, but was obliged to quit it next year. In 1598, it was again conſumed by fire, and in 1775 received much damage from a water ſpout. In 1178, Ada Counteſs of Northumberland, founded a monaſtery, dedicated to the virgin, near this burgh, but it is now entirely demoliſhed. The pariſh church of Haddington is a large and venerable ſtructure, and formerly belonged to the priory of St. Andrews, the patronage thereof was in the Earl of Haddington, and ſold about the end of the laſt century to the family of Hopetoun. There is alſo an elegant chapel for the epiſcopal communion, John Knox the reformer, Sir Richard Maitland of Lethington, who died in 1586, at the age of 90, his ſons the celebrated William Maitland and John Abbot of Kelſo, and ſome of their deſcendants were natives of this pariſh. The returned rent of this pariſh are 14645*l.* 16*s.* 11*d.*

In the appendixes to this paper, there are 1. Catalogues of returns at Amisfield. 2. Liſt of farms and ploughgates. 3. Mode of ſtriking the Fiars, or fixing the price of corn with the price as fixed from anno 1627, when the price of the firſt wheat per bolt was 16*s.* 8*d.* and in 1789, 1*l.* 3*s.* 6½*d.* 4. Act of Parliament relative to the burgh. 5. Deſcription on the Lauderdale monuments. 6 and 7. Copies of Charters.

Obſervations on the Duni Pacis. *By Sir* James Foulis, *of Collington.*

SIR James ſays every monument of antiquity is believed to have been made by theſe conquerors the Romans, eſpecially if the name wreſted to a Latin word or termination. Such muſt have been the caſe of the two great *tumuli*, near the Carron, in the ſhire of Stirling, from which the place Dunipace, is ſuppoſed to ſignify the hill of Peace, and the true name is thought to be *Duni Pacis*, and that the Tumuli were raiſed on occaſion of peace betwixt the Romans and Caledonians. But *Duni* is not a Latin word, but a Latin termination of the Gaelic word *Dun*; a name the place bore before the Romans came thither, and *Pacis* we have no authority to believe was uſed to ſignify peace, at the time theſe *tumuli* were raiſed.

Sir James concludes that theſe tumuli were raiſed as funeral monuments by each army for its own men. The place called *Dun-abas* i. e. the Hills of Death. (Obſerve here that b, in Gaelic is pronounced p). To raiſe ſuch tumuli was the cuſtom of the country where they ſtand. Where the ground was ſtony, they formed theſe tumuli of ſtones and called them Cairns. It is propable this battle was bloody, and the mount raiſed larger than uſual, and thence called *Duna* or hill. The Romans he obſerves, always ſet up wrought ſtones with inſcriptions, but none ſuch are found here, and he doubts not on digging at Dunipace, but proofs would be found of theſe being funeral monuments.

Deſcription of the Encampments on the Hill of Burnſwork.

OUR author ſays he had lately an opportunity of viſiting a hill in Annandale N. W. of Annan eight miles, (detached from the S. ſide of that chain of mountains, which runs from Northumberland to Galloway), which is called Brunſwork. This hill attracks the attention of the Antiquary, by the remains of encampments, with which it is covered. On each ſide is a camp, giving evidence of its being formed by the Romans, and ſome fortifications on the top. Before you reach the ground at the foot of the hill, there is a riſe of near two miles, at firſt gentle, afterwards more difficult, near the top it is rocky and almoſt a precipice, eſpecially to the N. and W. On the top there is an irregular plain, devided into two by a hollow, and around the Weſt part which is circular, are the remains of a wall compoſed of earth and ſtones, and within it ſome marks of buildings. Traces of a wall may be ſeen round the Eaſtern part, except where it is rocky. Marks of a road may be alſo ſeen coming from the South to the top. Weſt there is a road cut in a ſloping direction down the rock. The fortifications on the Weſt part are about 180 yards diameter, the Eaſtern about 180 yards by 280. Near the center is a ſmall hillock of ſtones, now covered with earth. The camp lies S. E. about 100 yards from the ſummit, it has a rampart and ditch 8 yards perpendicular. This ſide meaſures 240 yards, and has three gates, the Eaſt ſide is 130 yards, and has one gate near the upper ſide, on the corner above is a ſtrong fortification, twenty yards ſquare, ſeperated from the camp, by a rampart and ditch. The town ſide is 260 yards, and has one gate in the middle. The Weſt ſide bends inwards, and has one gate, every gate is defended by a mount, and a deep ditch in front.

The camp N. W. is lower down, and longer than the firſt, but not ſo deep. It has gates likewiſe defended by mounts. South of this camp are ſome ſprings, one of which is large, and appears to have been fortified. On the plain there is a ſmall encampment nearly circular.

The whole ſuggeſted to our author, the idea of a ſiege, and that the natives had conveyed their cattle and effects to the top of the hill, and fortified it. The Romans had encamped their forces on each ſide the hill. This accounts for the difference in the form, and gates of the camp from their uſual mode. The gates are more numerous in front, to form the troops with greater expedition, and fortified to protect them in caſe of retreat. The principal attack has been where the hill is moſt acceſſible. The natives could have no water at top, and perhaps cut the road at the Weſt end to get down to the ſprings unobſerved. To prevent them the principal well is fortified. The party in the ſmall encampment were to watch the motions of the natives. If this was the caſe in the time of the Romans, it might ſerve the ſame purpoſe in the wars between the Engliſh and Scots, and to this period we may refer the road from the lower ground and part of the fortification at the top. The Cairn on the Eaſtern ſummit was perhaps raiſed as a place for lighting fires. But the camps muſt have been formed by the Romans, and perhaps by Agricola, as the hill is near the road he is ſuppoſed to have marched. The banks of the Clyde above Lanerk afford a fertile ſubject for an antiquary. A Roman army was wintered in that country, the head quarters three miles Eaſt of Lanerk, and there are ſmall cantonments along the eminences on each ſide of the river for ſeven or eight miles. Several remains of the Roman cauſway are ſtill to be ſeen, and a bridge near Lanerk uſually aſcribed to the Picts, is perhaps Roman. At the foot of a hill called Tinto, are plain veſtiges of a Druidical temple, perhaps the largeſt in North Britain.

Memoirs of the Life of Sir James Steuart Denham, Bart. *By the* EARL *of* BUCHAN.

HE was the ſon of Sir James Steuart, of Goodtrees, ſolicitor-general for Scotland, by Anna, daughter of Sir Hugh Dalrymple, third ſon of the learned lord viſcount Stair. He was born October 10, 1713, O. S. and educated at the ſchool of North Berwick, from whence, at fourteen, he was removed to the univerſity of Edinburgh, and went through a complete courſe of the ſciences and languages there taught, and alſo the Roman and Scottiſh law. From thence, having undergone a public examination, he went to the bar of the college of juſtice, as an advocate.

A few months after he ſet out on his travels, and viſited Holland, Germany, France, Spain, and Italy; he ſtudied the laws, manners and improvements of theſe countries, and returned in 1740. In 1743, he married lady Frances Wemyſs. A few months after he took an active part in oppoſition to Mr. Dundas, of Arniſton, one of the ſenators of the college of juſtice, who had omitted to call over his name on the roll of electors. Sir James proſecuted him, and pleaded his own cauſe in ſo maſterly a manner, that Mr. Dundas, although a judge, came down from the bench, and defended himſelf at the bar. This afforded great hopes of his profeſſional abilities, but ſome political connections he had formed at Rome prevented him from availing himſelf of ſuch an introduction. After this he ſpent two years at his country ſeat, ſurrounded by his friends, among whom were many who afterwards engaged in the attempt to place prince Charles on the throne. From this conduct his name was tranſmitted to government as privy to the rebellion; this obliged him to become a fugitive from his country, but the time of his baniſhment he employed for the good of that country, the inſtruction of mankind, and the illuſtration of the republic of letters. He returned to his paternal eſtate, and in 1771, the India Company employed him to conſider on a method to regulate the coin in their ſettlements, and next year at their requeſt he publiſhed a treatiſe on "the principles of money applied to the preſent ſtate of the coin in Bengal."

About the ſame time he wrote a critique on the *Syſtem de la Nature*, which was never publiſhed. He alſo wrote a plan for a general uniformity of weights and meaſures, which in 1778 he finiſhed, and tranſmitted to the writer of this.

Next year he began to enquire minutely into the ſtate of the diſtillery and brewery, the reſult of which he publiſhed in the Edinburgh Evening Courant, October 2, 1779, the *particular diſcuſſion* he tranſmitted to a friend in parliament. This publication prevented the counties of Scotland from taking ſome crude reſolutions.

In 1780, by cutting his toe nail, it brought on a mortification, of which he died October 26, leaving iſſue the preſent Sir J. S. Denham.

He reſided long in France, particularly at Angouleſme, where he collected thoſe facts relating to the revenue, which laid the foundation for ſome chapters in his Principles of Political Œconomy. By converſing with the intendant and his ſubſtitute, and by long ſtudy and application, he was enabled to compoſe his chapter on French finances.

In 1757, at Frankfort, he publiſhed his *Apologie du ſentiment du Chevalier Newton ſur l'Ancienne chronologie des Grècs*, which was written in 1755. This work has great merit, and his great work on political œconomy it is needleſs to praiſe.

During the war between France and Great Britain, by having ſome letters addreſſed to him he became the object of ſuſpicion, and was impriſoned until the miſtake was diſcovered. Some time after the peace of Paris, he was permitted to come incognito to London, and a pardon ſolicited through ſeveral channels, particularly through the elder Mr. Pitt, by the writer of this, then lord Cardroſs, but the ſolicitation proved abortive. However, in 1767, he was reſtored.

Account of the Pariſh of Uphall. By the Right Hon. the EARL *of* BUCHAN.

THIS pariſh, which is the writer's reſidence, affords very few circumſtances of conſequence to any but thoſe immediately intereſted in it. It is ſeated at the eaſtern verge of the county of Linlithgow; and contains 3922¼ ſtatute acres, and about 600 inhabitants, who ſeem on the increaſe. Its ſoil is in general a rich mouldering clay, productive in moſt of the uſual objects of agriculture. Its minerals are coals, free-ſtone, iron-ſtone, lime-ſtone, whin-ſtone, baſalts, ſlate, coarſe fullers earth, potters clay, brick clay, ſtone marle, and ſhell marle. It has no manufactures, and its antiquities are inconſiderable. The greateſt part of the pariſh was very anciently in the poſſeſſion of the family of Sutherland, from whom it paſſed to the Douglaſſes, and ſucceſſively to the Keiths Earl Mariſchal, the Earls of Winton, and the Oliphants.

An Enquiry into the original Inhabitants of Britain. By Sir JAMES FOULIS, *of Colinton, Bart.*

FROM a number of quotations from the Roman poets and hiſtorians, the writer thinks it probable, "that from the firſt invaſion of the Romans, until Britain was relinquiſhed by them, they named the country *Britannia*, *Caledonia*, and ſometimes *Thule*;—that they named the inhabitants at large *Britanni*, *Caledones*, *Picti*;—that they did not give theſe names to one peculiar part of the iſland or people, but applied them to the inhabitants and country on the banks of the Thames, as well as to thoſe north of the Grampians, however they might be divided into different tribes." He conſiders as fabulous the account given by later writers, that a colony of Goths from Germany or Scythia eſtabliſhed themſelves in the Orkneys and along the eaſtern coaſts of Scotland under the name of *Picti*; and refutes the argument from language uſually adduced in favour of that opinion.

Obſervations on the Hammermen of Edinburgh. By W. C. LITTLE, *of Liberton, Eſq.*

THOUGH we are not informed by this writer of the meaning of the term *Hammermen*, it appears to include all thoſe mechanic trades, which work with the hammer, as the various branches of the ſmith's, armourer's, brazier's, pewterer's, and ſadler's occupation. A chronological account is here given, from the records of the corporation, of the various *eſſays* required on admiſſion into theſe ſeveral companies; which are only curious as ſhowing the late introduction of the arts, and their gradual progreſs, in that city.

An Account of the Magnetic Mountain of Cannay. By G. DEMPSTER, *of Dunnichen, Eſq.*

NEAR the harbour in the iſle of Cannay, on a hill of ſome height called the *Compaſs-hill*, is a hole dug about a foot or two in depth. A compaſs placed in this hole is inſtantly diſturbed, and veers about to the eaſtward, till at length the north point ſettles at due ſouth, and remains there. At a very ſmall diſtance from the hole, the needle recovers its uſual poſition. This circumſtance was known to Martin, when he wrote his hiſtory of the Weſtern Iſlands, but the compaſs then ſettled at due eaſt. A diſcovery was lately made by Hector M'Neil, Eſq. tackſman of the iſland, that the ſame effect is produced under a rock in the harbour, about half a mile to the ſouth of Compaſs Hill, and a continuation of it. On a boat's paſſing under the center of this rock, almoſt touching it, the compaſs veered about to the ſouth. The effect is confined to a very ſmall part of the rock. A piece of the rock below broken off and applied to the compaſs, produced no alteration. This iſland has many columnar appearances, like that of Staffa.

On the Offices of Thane and Abthane. *By* Robert Riddel, *of Glenriddel, Eſq.*

A Thane, (which ſignifies a ſervant) held under the king a juriſdiction over a diſtrict called a Thanedom, and afterwards a Sheriffdom or county. His office was to give judgment in all civil and criminal caſes within his thanedom. This title gave way to that of Earl, introduced from England by Malcolm Canmore, and fell into total diſuſe in the year 1476.

As to the very ancient title of *Abthane,* its import is not well known. The laſt perſon who bore it was Crinan, father of king Duncan I. He is generally thought to have been chief juſticiary of the kingdom, and ſteward of the crown-lands in the weſtern iſles, as well as in a large diſtrict on the main land.

An Account of a Combat between the Macpherſons and the Davidſons. *By* Sir James Foulis, *Bart.*

A more accurate relation of a judiciary combat at Perth, in the reign of king Robert II, than has before been given.

An Account of the Manner in which the Lammas Feſtival uſed to be celebrated in Mid Lothian, about the middle of the eighteenth Century. *By* James Anderson, *L. L. D.*

THIS is a record of an ancient rural cuſtom, which having now fallen into diſuſe, would probably ſoon have been forgotten, without ſuch a memorial.

On the approach of Lammas-day the *Herds* aſſociated in bands, and each band agreed to built a tower of ſod, uſually about four feet ſquare at bottom, and eight feet high, tapering to the top. As the neighbouring bands watched an opportunity to deſtroy it, it was attended night and day, on alarm given by ſounding a horn, and frequent ſkirmiſhes enſued. On Lammas-day each band choſe a captain, procured colours, and marched to the tower armed with cudgels, when they made merry. If any hoſtile band appeared, perhaps a ſkirmiſh enſued, and in the afternoon races were run by the ſwifteſt for ſmall prizes. Dr. Anderſon ſays this was practiſed about thirty years ago, but he could never diſcover any trace of it in Aberdeenſhire.

A Diſquiſition into the proper Arrangement of the Silver Coins, applicable to the firſt four James's Kings of Scotland. *By* James Cummyng, *Eſq. Keeper of the Lion Records.*

A Difficulty ariſes in the arrangement of the coins of Scotland, reſpecting the ſilver pieces of the four firſt James's, which has proceeded from their arrangement in the *Diplomata* & *Numiſmata Scotiæ,* wherein an arched or imperial crown is given to James II. This form of crown was not adopted in England till the reign of Henry VII. nor in France till that of Francis I.; and as it appears to have been the cuſtom in the

Scotch mint to imitate the practice of other nations, it ſeems moſt probable to this writer that the coin in queſtion, with the imperial crown, belongs to James IV. not to James II. He ſtrengthens this opinion by authorities.

An Account of the Province of Biſcay in Spain. By the Rev. Dr. JOHN GEDDES.

THIS paper accompanied a preſent to the Society of a copy of the privileges and municipal laws of the *Seniorio* or Lordſhip of Biſcay in Spain; and contains a relation of a tradition, mentioned by the Spaniſh hiſtorians, of the Scottiſh deſcent, by the female ſide, of the lords of Biſcay; and a brief account of the moſt remarkable of the laws.

An Account of the Money, Coins, and Weights, uſed in England, during the Reigns of the Saxon Princes. Extracted from a Manuſcript, written by JAMES STIRLING, *of Leadhills, Eſq.*

BEFORE the Norman conqueſt, all coins were denominations of weight; in order, therefore, to obtain an accurate idea of Engliſh money at that period, it is neceſſary to inveſtigate the weights. From this inveſtigation, and the compariſon of weights in other countries, the following table is formed.

TABLE of the value of the Engliſh Money, as it ſtood at the Norman Conqueſt, reduced to preſent Sterling, to which is added, the weight of each denomination in Troy grains.

	L.	s.	d.	Troy Grains.
The great pound of 15 ounces	3	8	9	6562.5
The ſmall pound of 12 ounces	2	15	0	5250.
The great mark of 10 ounces	2	5	10	4375.
The ſmall mark of 8 ounces	1	16	8	3500.
The ſilver mancus of 1½ ounce	0	6	10½	1156.375
The ora or ounce	0	4	7	437.5
The ſhilling four in the ounce	0	1	1¾	190.375
The thrims or ⅛ of the ſilver mancus	0	0	10¼	144.5468
The great penny 16 in the ounce	0	0	3½	27.344
The middle ſtandard penny 20 in the ounce	0	0	2¾	21.875
The ſmall penny 24 in the ounce	0	0	2¼	18.229
The gold ſolid of the Greek Emperors, called the gold mancus	0	8	11¾	71.428
The gold ſolid of Charlemagne, alſo called the gold mancus	0	8	9½	70.
The denier of Louis the Debonnaire, called the ſceata	0	0	3¼	26.25

It is to be obſerved that there was at that time no Engliſh real coin larger than the penny; the other denominations were monies of account.

The old Engliſh merchant pound was that of 25 ſhillings ſterling, equal to 15 ounces troy-weight. By this pound they compoſed their charre, or cart load, conſiſting of 2100 of theſe pounds, and thus ſubdivided;

12 pounds = 1 ſtone Or, 12½ pounds = 1 ſtone
5⅚ ſtones = 1 fodmel 14 ſtones = 1 wey
30 fodmels = 1 charre 12 wey = 1 charre.

This merchant's pound being to the Paris pound, as 21 to 20, it follows, that the charre is equal to 2000 Paris pounds, = 20 quintals = 1 ton.

But though the charre be really the Paris ton, its ſub-diviſions by ſtones and fodmels are Engliſh, and anſwer without fractions to the averdupois weight, as follows:

12 averdupois pounds = 1 ſtone
6 ſtones — = 1 fodmel
30 fodmels — = 1 charre.

The averdupois pound is to the merchant's, as 35 to 36.

Account of the Iſland of Icolumkill. By the Right Hon. the Earl of Buchan.

Conſiſts chiefly of deſcriptions of the religious ruins, and tombs.

Of the Roman Haſta and Pilum; of the Braſs and Iron uſed by the Ancients. By the Rev. Mr. John Grant, *Miniſter of Dundurcas.*

ON occaſion of ſome copper antiquities found in a moſs near Nairn, which anſwer to the deſcription of the heads of Roman ſpears, the writer attempts to prove, by various authorities, that the Romans made uſe of copper and braſs for inſtruments of war, long after they were acquainted with iron.

The Life of Mr. James Short, Optician. By the Earl of Buchan.

MR. Short was ſon of John Short, joiner, in Edinburgh, born June 10, old ſtile, 1710; at ten years of age he was entered on Herriot's foundation, about which time he began to ſhew a genius for mechanics, in making little cheſts, bookcaſes, &c. At twelve he went to the high ſchool Edinburgh, and in 1726 to the Univerſity, where by a regular courſe of ſtudy, he arrived at the degree of Maſter of Arts, and paſſed his trials for a preacher of the church of Scotland in 1732; but, attending Mr. M'Laurin's mathematical lectures, he ſoon loſt all reliſh for eccleſiaſtical ſtudies, and turned his thoughts to the buſineſs he afterwards purſued that of an optician, in which he ſhewed a great proficiency in caſting and poliſhing metallic ſpecula for reflecting teleſcopes. His ſpecula were parabolical, as pointed out by Sir Iſaac Newton.

In 1736 he was called to London, to inſtruct the Duke of Cumberland in the mathematics, and while in London was elected a fellow of the Royal Society. In 1739 he attended the Earl of Morton to the Orkney iſlands, and afterwards ſettled in London, where, in 1743, he was employed to make a reflector of 12 feet focus.

He died in 1768, leaving behind him a fortune of 20,000l.

Remarks made in a Journey to the Orkney Iſlands. By PRINCIPAL GORDON, *of the Scots College, in Paris.*

THE writer firſt deſcribes the general appearance of the inhabitants of Orkney, which ſtrongly denotes their German origin. He then gives an account of the remains of what is called a Pictiſh fort, on South Ronaldſha, but which he thinks of Norwegian conſtruction. Kirkwall, in the iſle of Pomona or Mainland, affords a deſcription of the ruined cathedral, and other remains of antiquity. The ſemicircle and circle of ſtones near the lake of Stenhouſe, which have exerciſed the conjectures of different perſons, are noticed and declared to be the remains of Scandinavian temples. A ſtone with a hole in it, near the ſemicircle, is rendered remarkable by the traditionary cuſtom, that when a promiſe of peculiar ſanctity is to be made, the contracting parties join hands through this hole. Such a contract is called, *the promiſe of Odin.* The only natural phenomenon mentioned by this writer, is the appearance of certain ſtones in the perpendicular cliffs above the ſea, which are marked with variouſly ſhaped figures, chiefly oval and triangular. Theſe figured ſtones ſeparate in ſtrata from the rocks, and when waſhed away, are ſucceeded by others. No marks are found on the part of the ſtone attached to the rocks, till after expoſure to the air; whence they are undoubtedly occaſioned by the chemical action of the ſea air or water on particles in the ſtone.

The paper is concluded with an obſervation of the miſerable deficiency of the people of Orkney in fixed weights and weighing inſtruments, which ſubjects them to the groſſeſt fraud and oppreſſion.

Deſcription of an ancient Obeliſk in Berwickſhire. By ROGER ROBERTSON, *Eſq. of Ladykirk.*

THIS is a ſtone monument, with a ſquare baſe, a pyramidal ſhaft, and a round head. The ſhaft has on one ſide a rude carving of a man and a dog, on two ſides a croſs, and on the other a long ſword, with an armorial bearing belonging to the name of *Soules.* The writer conjectures it to have been erected about the time of John Baliol.

Obſervations and Facts concerning the Breed of Horſes in Scotland, in ancient Times.

By ROGER ROBERTSON, *Eſq. of Ladykirk.*

THE moſt ancient evidence this writer has found of the breeding of horſes in Scotland, is a grant by Gilbert de Umfraville, before the year 1200, to the monks of Kelſo, of the tenth of foals bred in his ſtuds. From that time the exportation of horſes into England became a profitable branch of commerce. It was checked by a ſtatute of David Bruce in 1369, promoted again by James I. and totally prohibited in 1567. The original breed of Scotland was chiefly ſmall-ſized pacers, but was improved by foreign mixtures under ſeveral of the kings. In the time of James V. racing and horſe-courſing were much in faſhion with all ranks. The number of horſes kept appears to have been very great, and in ſome of the inroads into England, the whole army was mounted on horſeback.

An Account of ſome Remains of Antiquity in the Iſland of Lewis, one of the Hebrides. By COLIN M'KENZIE, *Eſq.*

THESE antiquities are, 1. *Circles of Stones*, which are generally ſuppoſed to have been Druidical places of worſhip. 2. *Monumental Stones.* 3. *Cairns.* 4. *Round Forts or Duns.* Theſe, which have been deſcribed in the Highlands by Mr. Pennant and Mr. Cordiner, are very common in Lewis. They are univerſally allowed to have been built by the Norwegians. They reſemble in appearance a glaſs-houſe; the wall is compoſed of two ſhells, the inner one perpendicular, the outer inclining towards it, and faſtened by large croſs ſtones, which form winding ſtaircaſes between the two: there are ſeveral window-like apertures inwards. They ſeem calculated only to protect a ſmall body from a ſudden attack. 5. *Religious Places.* Theſe are ſmall buildings, generally about 12 feet long, and cemented with clay, called *Tiawple*, and named after ſome holy man. They were probably a kind of hermitages, in which perſons retired either from perſecution, or from the cares of the world. 6. *Caſtles.* The remains of only one are mentioned.

An Account of the Pariſh of Liberton in Mid-Lothian, or County of Edinburgh. By the Rev. THOMAS WHYTE, *Miniſter of that Pariſh.*

THIS is a very particular account of the hiſtory and preſent ſtate of the pariſh, with its ſeveral baronies, and biographical records of their poſſeſſors, the ſucceſſion of miniſters, and all other local circumſtances, intereſting to an inhabitant of the place, but of little importance to general literature. The pariſh of Liberton is large and tolerably fertile: it contains 3457 ſouls: the annual average of chriſtenings is 108; of burials, 88; of marriages, 20. The people are for the moſt part engaged in rural occupations, and in the working of coal and lime. In an *Appendix* ſubjoined to this paper, are given three old charters, ſome account of the coal and lime works, an enumeration of the people in the different villages, extracts from the pariſh regiſter, and valuations of the rents, tythes, and ſtipend.

An Enquiry into the Expedients uſed by the Scots before the Diſcovery of Metals. By WILLIAM CHARLES LITTLE, *Eſq. of Liberton.*

THIS is a very ſlight comment upon ſome ſtone arrow and axe heads, and other articles, in the Society's Muſeum, which are ſuppoſed in ſome ancient unknown period to have ſupplied the place of metal weapons.

Obſervations on the Viſion; a Poem firſt publiſhed in the Miſcellany, or Collection of Scottiſh Poems called the Evergreen.---by Allan Ramſey, anno 1724. *By* WILLIAM TYTLER, *Eſq. of Woodhouſlee.*

AFTER adducing proofs that the real author of the *Viſion* was Allan Ramſay himſelf, the nominal editor, Mr. Tytler adds a few obſervations on the purpoſe and character of that poem.

Three

Three Scottiſh Poems, with a previous Diſſertation on the Scoto-Saxon Dialect. By the Rev. ALEXANDER GEDDES, *L. L. D.*

THIS writer begins his diſſertation by obſerving, that thoſe who for near a century paſt have written in Scots, have not duly diſcriminated its genuine idiom from its vulgarities. They have thought it ſufficient to interlard their compoſition with low words and trite proverbial phraſes, entirely neglecting grammatical analogy and critical accuracy. In enquiring into the origin of the Scottiſh language, he affirms that its original identity with the Engliſh is hardly queſtionable. The Anglo-Saxons introduced it into Britain about the middle of the ſixth century, and it ſoon ſpread over all the ſouthern parts of the iſland, except thoſe to which the original inhabitants retired, where the Celtic was ſtill retained. Theſe two languages ſeem very little to have mixed; nor was the Saxon-Teutonic much altered, till the Daniſh invaſion. The language of the Danes, being a ſiſter dialect, coaleſced with and ſomewhat changed the Saxon; but the Norman conqueſt altered it more, though the violent attempt of the conqueror to ſubſtitute the French in its ſtead, did not ſucceed. This Normanic-Dano-Saxon is the preſent Engliſh tongue, though much amplified and embelliſhed by later mixtures and alterations.

The introduction of the Saxon language into Scotland, is by ſome modern writers referred to a ſuppoſed original ſettlement of German Goths in the lower and eaſtern parts of Scotland, under the name of Picts. But that the dialect of the Picts was Gothic, appears improbable to Dr. Geddes, from the names of all the rivers, mountains, towns, &c. on the eaſtern coaſt, which are evidently Celtic, and from the names of the Pictiſh kings and other remains. Upon the whole, he thinks it may be taken for granted, that the Scots received their Saxon language from England. In order to account for its progreſs and peculiarities, he ſuppoſes that the more ſouthern provinces may have uſed the language of their Engliſh neighbours, even before the Daniſh invaſion; for Oſwy, king of Northumberland, in 650 made both Picts and Scots tributary, and many Engliſh ſettled in the conquered provinces; and when the Picts recovered their poſſeſſions, they retained part of the Engliſh as captives; to whom great acceſſions were at different times made by the inroads on the Engliſh border. By theſe means, and the intercourſe of the two nations during a long period, the Saxon language muſt have made a continual progreſs, as being that of the more civilized people; and it was hitherto received untainted with Daniſh or Norman mixture. In the reign of Henry II. when Engliſh garriſons were introduced as far as Edinburgh and Stirling, they would carry with them their Normanized Engliſh. But the reign of Malcolm Kenmore, who had been bred in England, and married an Engliſh princeſs, ſeems to have been that of a general denization of Saxon in Scotland; and an inundation of religious orders chiefly from England, in the reign of David, would alſo greatly ſerve to the propagation of the language. The expeditions of Edward I. and III. ſeem to have baniſhed the Celtic from the eaſtern coaſts as far as Buchan, and their numerous garriſons contributed to diffuſe the Engliſh over all the Lowlands. From the reign of James I. when acts of parliament were written in it, a ſufficient number of books and manuſcripts are left to afford a juſt idea of the Scoto-Saxon dialect.

On analyſing this dialect Dr. Geddes finds it to be compoſed, 1. and chiefly, of pure Saxon; 2. of Saxonized Celtic, whether Welch, Pictiſh, or Erſe; 3. of

Saxonized Norman or old French; 4. of more modern French Scoticized; 5. of Daniſh, Dutch, and Flemiſh occaſionally incorporated; 6. of words borrowed from the learned languages. Theſe mixtures, however, vary in different parts according to ſituation, employment, and other circumſtances. Our author then proceeds to ſhow that this dialect was, at the union, equal in all reſpects, and in ſome (indeed, as he ſtates it, in almoſt *all*) ſuperior to the Anglo-Saxon. This he attempts to prove by a circumſtantial compariſon of the two tongues, under the heads of *richneſs*, *energy*, and *harmony*. He concludes with a ſyſtem of orthography of the Scotiſh, according to a table of ſymbols and powers of letters, explained by obſervations; which are followed by hints for forming a Scoto-Saxon Lexicon.

Dr. Geddes next preſents the reader with the practice of his theory relative to the Scottiſh language, in three poetical compoſitions; the firſt, an epiſtle to the Members of the Scottiſh Society of Antiquaries, the ſubject of which is the praiſe of the language and literature of his country; the others, a tranſlation of the firſt Eclogue of Virgil, and of the firſt Idyllium of Theocritus. Theſe laſt are printed with accents according to his own ſyſtem of orthography.

Diſſertation on the Scottiſh Muſic. By WILLIAM TYTLER, *Eſq. of Woodhouſlee.*

IT is the purpoſe of this eſſay to fix the era of the moſt ancient Scottiſh melodies, and to trace the hiſtory of the national muſic down to the modern times.

The ſimplicity and wildneſs of ſeveral of the old Scottiſh airs denote them to be the production of a paſtoral age, in which no other muſical inſtrument was uſed than that of a very limited ſcale of natural notes. They conſiſt of one meaſure only, and have no ſecond part. Their diſtinguiſhing ſtrain is plaintive and melancholy, an effect in a great degree owing to the conſtant uſe of the concordant tones, the third and fifth of the ſcale, often ending upon the fifth, and ſome on the ſixth.

The ſcience of muſic was certainly known in Scotland before the fifteenth century, for king James I. is celebrated by all the Scottiſh hiſtorians, not only as a performer, but as a theoriſt and compoſer of airs to his own verſes. Many of his compoſitions, Mr. Tytler ſuppoſes to be ſtill remaining diſguiſed under other names, and adapted to modern words. He further attempts to prove, "that the Scottiſh melodies, ſo far from being either invented or improved by an Italian maſter, were made the models of imitation in the fineſt vocal compoſitions of one of the greateſt maſters in Italy of his age." His teſtimony for this poſition is the following paſſage from the *Penſieri Diverſi* of *Taſſoni.* "We may alſo reckon among ours, *James king of Scotland*, who not only compoſed ſacred pieces in ſong, but alſo, of himſelf, invented a new muſic, plaintive and melancholy, different from all other. In which he has ſince been imitated by *Carlo Geſualdo, prince of Venoſa*, who in this our age has alſo adorned muſic with new admirable inventions." Mr. Tytler underſtanding the words of Taſſoni to mean, that the prince of Venoſa imitated James I. not only in the circumſtance of being a compoſer, but in the particular kind of compoſition which he adopted, proceeds to ſhow, that the *Scottiſh melodies* were what was thus introduced into Italian muſic, which before had nothing but *artificial harmony*. This, indeed, ſo far as relates to the ſuppoſed introduction, is mere hypotheſis. It is more certain that James I. introduced organs, and other muſical inſtruments into Scotland.

The great era of poetry as well as of muſic in Scotland, Mr. Tytler imagines to have been from the beginning of the reign of James I. to the end of that of James V. In this period the bards were conſiderable perſons in every great family, and there were alſo itinerant minſtrels, who went about reciting heroic ballads, and other popular compoſitions. From theſe many old ſongs probably originated, as certainly did that ſpecies of muſic called a *Port*, of which one belonged to almoſt every great family. This was not in the martial, but rather in the plaintive ſtrain. The *Pibrach* or Highland march to battle, was fitted for the bagpipe only. From the ſimple melodies of James I. the writer is led by an inſenſible gradation, to the ſecond epoch of Scottiſh ſong, from the beginning of the reign of James IV. to the end of queen Mary; in which, with a more varied melody, there is a degree of artful modulation ſhewn in the introduction of the ſeventh of the key, a ſtrain peculiarly characteriſtic of the ancient Scottiſh ſongs. The third era is from queen Mary to the reſtoration, in which ſeveral ſongs are claſſed by Mr. Tytler. The laſt is from the reſtoration to the union, a period to which various fine ſongs are known to belong, from their more regular meaſure and modern air. The church muſic before the reformation has nothing in common with the national ſong-melodies. Since that period, beſides the ſolemn pſalm tunes, there have been ſome very odd and indecent applications of ludicrous ballad-tunes to godly ſubjects.

The Scottiſh ſongs are highly expreſſive of the paſſions, particularly thoſe of the melancholy kind. They require a perfect knowledge of the language in the ſinger, with taſte to mark out the ſignificant words, and diſtinct articulation. They admit of no cadence, or fanciful deſcant at the cloſe.

On the Faſhionable Amuſements and Entertainments in Edinburgh in the laſt Century, with a Plan of a grand Concert in Muſic on St. Cecilia's Day 1695. *By the ſame.*

THIS paper contains a ſhort account of the amuſements in Edinburgh, during the reſidence of James duke of York at Holyrood-houſe in 1681 and 82; and ſome anecdotes of muſical performers.

Topographical Deſcription of the Pariſh of Aberlady. By the Rev. Dr. NIEL ROY, *Miniſter of that Pariſh.*

The number of perſons in this pariſh is 800; which is probably leſs than formerly. We find nothing in the deſcription of importance to readers in general.

Letter from the Counteſs Dowager of Nithſdale to her Siſter the Counteſs of Traquair, giving an Account of the Earl's Eſcape out of the Tower in 1716.

This intereſting relation is not capable of abridgment.

A Letter from the late Dr. Henry, Author of the Hiſtory of Great-Britain, to William Tytler, Eſq. with the Anſwer; and a Diſſertation on the Marriage of Queen Mary with the Earl of Bothwell.

DR. Henry, after expreſſing his conviction of the cruelty with which queen Mary was treated when living, and the calumnies her memory has undergone, yet acknowledges the difficulty he finds in vindicating her conduct with reſpect to her marriage with Bothwell. Mr. Tytler replies with a diſſertation on that marriage, the purpoſe of which is to prove, not only that Bothwell carried her off without her concurrence, but that he *actually raviſhed her*, which made the marriage a matter of neceſſity. His evidences of this fact are, the words of the rebel aſſociates themſelves in their account to queen Elizabeth's envoy, and the teſtimony of Sir James Melvill.

Letter under the Privy Signet of King James VI. addreſſed thus: "To o.r truſtie and well beloved y.e Proveſt, Bayliffes, and Councell of y.e Burrough of Dundie."

THIS is dated from Whitehall, December 31, 1616, and requires the borough to ſend its commiſſioners to a convention of the eſtates in Scotland, ſummoned to meet in Edinburgh on the 5th of March next.

Letter from the Privy Council of Scotland, directed thus: "To the Earle of Callander, Sherrif principal of the Shyre of Stirling. In haſte."

This (without date) relates to garriſoning and providing the houſes of Cardroſs and Glentirran.

An original Letter of Biſhop Burnet.

WHEN Burnet was parſon of Salton, in the year 1666, he drew up a memorial of the grievances Scotland lay under from the bad conduct of the biſhops, and ſent copies of it, ſigned by himſelf, to all the biſhops of his acquaintance. For this freedom he was called before the biſhops and treated with great ſeverity. The preſent letter is an apologetical one for his conduct on the occaſion, addreſſed to the biſhop of Edinburgh.

Inſtructions for William Stewart, to be obſerved by him in the Duke of Queenſberry's Family during his Grace's Abſence in England.

Dated, Dec. 26, 1695. Relative to domeſtic economy.

Licence by Lord Bellenden, Lord Treaſurer Depute, in favour of William Selkirk, &c. to eat Fleſh in forbidden Times. Febr. 1665.

Addreſs

Addreſs of one hundred and two Chief Heritors and Heads of Clans in the Highlands of Scotland, to King George I. *on his Acceſſion to the Throne, which, by Court Intrigue, was prevented from being delivered to his Majeſty.*

The neglect ſhewn to this very loyal (and artful) addreſs, is here ſtated to have been the immediate cauſe of the rebellion in 1715.

On Agricola's Engagement with the Caledonians, under their Leader, Galgacus.

By R. BARCLAY, *Eſq. of Urie.*

FROM the remains of a large camp, apparently Roman, at *Raedykes*, and the ſituation of the ſurrounding country (illuſtrated by a map) Mr. Barclay is led to infer, that this was the poſt of Agricola, after his deciſive battle with Galgacus, which he ſuppoſes to have been fought at the *Kempſtonehill*, as Agricola was advancing northwards from *Arduthy*. Theſe places are in the county of Mearns, near Stonehive.

Proceedings of the Aſſociation for promoting the Diſcovery of the Interior Parts of Africa. 8vo. 1791.

THE narrative of the proceedings of this Society is written by one of the members of the committee, and is preceded by a plan of the aſſociation.

The author obſerves, that, of all the objects of inquiry, there are none that both learned and unlearned ſo much wiſh to inveſtigate, as the natural hiſtory of countries hitherto unexplored. By ſea, little remains to be examined; but by land, much of Aſia, a large portion of America, and almoſt the whole of Africa are unviſited and unknown.

In Aſia there are few extenſive diſtricts, of which we are wholly ignorant, and the expected travels of Mr. Forſter, who returned from Hindoſtan to Europe, by way of Laldong, Jummoo, Caſhmire, Cabul, Herat, and the Caſpian Sea, will probably ſhew the manners, cuſtoms, &c. of the tribes that inhabit the mountains north of Lahore, the celebrated country of Caſhmire, and the riſing empire of the Seiks, and the particulars of their religion, which profeſſes to bring back the Hindoos from the worſhip of images, to that of the one God.

To our knowledge of America, a large addition may be expected from the perſons ſent about two years ſince by ſome inhabitants of Canada, to traverſe the continent from the river St. Laurence, to the oppoſite ocean.

Some progreſs has alſo been made in the diſcovery of particular parts of Africa. Dr. Sparman, Mr. Patterſon, and Mr. Bruce have furniſhed important obſervations, and from theſe, with the knowledge Col. Gordon, commander of the Dutch troops at the Cape of Good Hope has acquired, the ſouthern extremity of Africa may be conſidered as explored.

But the map of the interior parts preſent an extended blank. The courſe of the Niger, the places of its riſe and termination are ſtill undetermined. Our knowledge of the rivers Senegal and Gambia has not been improved ſince De la Brue and Moore. Nor have we profited by the information we have poſſeſſed on the weſtern coaſt.

Deſirous of reſcuing the age from a charge of ignorance in this reſpect, a few individuals have formed a plan for the diſcovery of the interior part of Africa. Each member is to ſubſcribe five guineas a year for three years, at the end of which time he may, on giving notice, withdraw; all future members to be admitted by ballot. A committee of five have been elected, with powers to chuſe perſons for the diſcoveries, to carry on the correſpondence, and to manage the funds. The committee are not to diſcloſe any intelligence received from their agents, but to the committee at large, for which purpoſe a meeting ſhall be called by letter.

Chap. I. *Proceedings of the Aſſociation.* This aſſociation was formed June 9, 1788, and the committee proceeded to ſelect perſons to whom the geographical miſſion ſhould be aſſigned. Two gentlemen propoſed to undertake the adventure.

One, Mr. Ledyard, was an American, who for ſeveral years had lived with the Indians of that country, and ſtudied their manners. He had made a voyage round the world with Captain Cook, and having a deſire of penetrating from the North Weſt coaſt of America, to the Eaſtern ſhore, he determined to traverſe the vaſt continent from the Pacific to the Atlantic Ocean, and was preparing to embark in a veſſel to Nootka Sound, but the veſſel being ſeized, he determined to travel over-land to Kamſchatka, and embark from thence. With ten guineas only he went over to Oſtend, and proceeded by way of Denmark and the Sound to the capital of Sweden, and endeavoured to croſs the gulph of Bothnia on the ice, but finding when he came to the middle that the water was not frozen, he walked round the gulph to Peterſburg. Here he found himſelf without ſtockings or ſhoes, but procured relief from the Portugueze Ambaſſador, and obtained leave to proceed with a detachment of ſtores to Yakutz; he made this journey of ſix thouſand miles, and there met Mr. Billengs, an Engliſhman, whom he had known on board captain Cook's ſhip. From thence he went to Oczakow, on the coaſt of the Kamſchatka ſea, but being too late to embark that year, returned to Yakutz to winter. Here he was, on ſome ſuſpicion, ſeized, conveyed on a ſledge through Northern Tartary, and left on the frontiers of the Poliſh dominions. In the midſt of poverty, rags, and diſeaſe, he however reached Koningſburg, where he found friends that enabled him to reach England.

On his arrival in London he waited on Sir Joſeph Banks, who communicated to him the plan of the aſſociation for exploring Africa, and their wiſh to engage him, to which he readily aſſented, and the track pointed out to him was from Cairo to Sennar, and from thence weſtward in the latitude and ſuppoſed direction of the river Niger.

The other perſon engaged, Mr. Lucas, having been ſent to Spain when a boy, on his return was captured by a Sallee-rover, and carried a ſlave to the court of Morocco, where he continued three years. Being releaſed and ſent to Gibraltar, he was appointed vice conſul to Morocco, where he reſided ſixteen years, and then reviſiting England, he was made Oriental interpreter. This gentleman, with the conſent of the king, was nominated by the aſſociation, and was to proceed over the deſert of

Zahara from Tripoli to Fezzan; the committee having heard, that with this kingdom the traders of Agadez and Tombuctou, &c. had eſtabliſhed a regular intercourſe. He was to tranſmit by way of Tripoli, what intelligence he could collect, and return by way of Gambia, and the coaſt of Guinea. To enable this traveller to proceed, the committee advanced the money neceſſary.

Chap. II. Mr. Ledyard took his departure June 30, 1788, paſſed through Paris and Marſeilles, to Alexandria, and form thence having aſſumed the dreſs of an Egyptian traveller, proceeded by water to Cairo. While he was waiting to ſettle the neceſſary affairs for his journey, he was attacked by a billious complaint, of which he died.

In his journal, he remarks the wonderful difference between every object ſeen here, or in Europe; he deſcribes the view in ſailing up the Nile as very confined, that he ſaw no propenſity among the inhabitants to incivility: but found the villages miſerably poor; the huts of mud, full of dirt and vermin, and the common people wearing only ſhirts and drawers. At Cairo, he was entertained at a convent of Recollets: here he found the weather extremely hot, was introduced to the Aga, and promiſed the neceſſary letters of recommendation.

Of the Arabs he obſerves, that tatowing is as prevalent among them, as among South Sea iſlanders, the women tatow on the chin, they ſtain their nails red, and wear a maſk like the prieſts at Otaheité.

He ſaw at Cairo an Arab white woman, like the white Indians in the South Sea iſlands, and at the iſthmus of Darien; the dogs too were of the ſame ſpecies as the dogs at Otaheité. The Arabs of the deſarts, he ſays, have an invincible attachment to liberty, but it is ſingular they have no word to expreſs liberty in their language. The Mahomedans of Africa, are a trading, ſuperſtitious, and warlike ſet of vagabonds. He ſaw near 200 black ſlaves expoſed to ſale, who had been brought from the interior parts of Africa; their appearance ſavage, but not like priſoners of war, they had head ornaments, and their hair plaited in detached plaits of great length. Another parcel he ſaw came from Darfoor were moſtly women, and the beads and ſome other ornaments they had were Venetian. They were well formed, quite black, had the true Guinea face, and curled hair. Mr. Ledyard was informed that the king of Sennar was a merchant, and concerned in the caravans, that 20000 negro ſlaves are imported into Eygpt annually. Among ſome Sennar ſlaves, he ſaw three of a bright olive colour, but their heads uncommonly formed, the forehead the narroweſt, longeſt, and moſt protuberant he ever ſaw.

A caravan goes from Cairo to Fezzan, which they call a journey of fifty days, and as the caravans travel about 20 miles a day, the diſtance muſt be about 1000 miles; from Fezzan to Tombuctou is 1800 miles; from Cairo to Sennar about 600 miles.

The tranſactions give ſeveral extracts from Mr. Ledyard's letters, by which he appears diſintereſted, adventurous, and inured to hardſhips.

Chap. III. Mr. Lucas embarked at Marſeilles for Tripoli, where he was introduced to the Baſhaw, who promiſed him aſſiſtance for his journey to Fezzan. Soon after, he was informed that ſome tribes of the tributary Arabs had revolted, and that the frontiers of Tripoli, on the ſide of the deſart, were infeſted by their inroads, and that the Baſhaw was preparing an army to reduce them; but while Mr. Lucas was waiting, two ſhereefs, or deſcendants from the prophet, arrived as merchants from Fezzan to ſell ſlaves, ſenna, &c. and as their being deſcendants from the prophet ſecured their perſon and property from violence, they did not wait for the reſtoration of peace, but prepared to depart, and offered to take Mr. Lucas under their protection. One of theſe was about 35 years of age, ſon in law to the king, the other an elderly man named Imhammed. The Baſhaw being informed of this offer, ſent Mr. Lucas a mule for his journey, and the boy his ſon preſented him with a tent, and gave Mr. Lucas a letter of recommendation to the king of Fezzan.

On the 1ſt of February 1789, the ſhereef and Mr. Lucas left Tripoli with the caravan. The ſhereefs had ſent their heavy merchandiſe by ſea to Meſurata, they paſſed through Tajarah, a miſerable village of huts, and at night encamped on a ſandy eminence, piled their loads in a circle, lighted their fires, and lay down to ſleep without any covering but their blankets; Mr. Lucas having a tent, the ſhereef ſupped with him out of a wooden diſh of dried meats and of flour formed in balls, and dreſſed in ſteam. After the meal the ceremony of waſhing was performed, each man dipping his right hand into the ſame water, they then took coffee, ſmoaked, and laid down to ſleep. Next day they travelled among barren ſands, and ſaw neither man, beaſt, wood, or water.

February the 4th, they reached the ruins of Lebida, after which for twenty five miles they found a luxuriant vegetation, and ſaw the remains of a ſtupendous aqueduct which formerly conveyed water to Lebida. When they approached Meſurata they found the rebel tribe of Arabs had committed depredations. February the 7th they reached Meſurata.

The Governor of that place received Mr. Lucas with marks of attention, but ſaw little chance of his reaching Fezzan before the winter, on account of the war. The ſhereef Fouwad requeſted a ſafe conduct for 120 of the camels belonging to the rebels, to carry their goods, but this plan did not ſucceed, and Mr. Lucas, deprived of the opportunity of reaching Fezzan this year, and having diſcovered that the old ſhereef Imhammed had been employed by the king of Fezzan, and had travelled to Bornou and Nigritia, he determined to learn from him what he could. In the courſe of ſeveral conferences he learned various particulars, after which, taking leave of his fellow travellers, he went by ſea to Tripoli, from thence to Malta, Marſeilles, and to England.

Introduction of Chap. IV. Mr. Lucas did not wiſh to depend on the ſolitary evidence of Imhammed, but read over his account to the governor of Meſurata, who had formerly travelled to Fezzan, who ſaid that many particulars he knew himſelf, and many from the report of others, and that the ſhereef was a perſon whoſe details might be depended on. Meantime another confirmation of the truth of this account was fortunately obtained in England. The committee in London procured from Ben Ali, a native of Morocco, then in London, who travelled thither as a merchant, an account of thoſe countries ſouth of the deſart of Zahara, the reſult of theſe informations are contained in

Chap. IV. *Of Fezzan.* It is placed in the vaſt wilderneſs as an iſland in the ocean, and is ſituated ſouth of Meſurata. In eight days the traveller arrives at Wadan, where refreſhments are procured for the caravan. From thence in five hours they reach the deſart of Soudah, where no vegetable but the talk is ſeen to grow, a tree from which the lemon-coloured wood is taken which forms handles for tools. The paſſage of the deſart takes up ſome days, when the traveller finds a miſerable village, producing nothing but dates, brackiſh water, and Indian corn; from this village a day's journey conducts to the town of Sebbah, where are the remains of an ancient caſtle, and other venerable ruins, and in four days more he reaches Mourzouk, the capital of Fezzan.

This city is ſituated on the banks of a ſmall river, ſurrounded by a high wall for defence, and is diſtant from Meſurata 390 computed miles. Eaſtward of Mourzouk is the town of Queela, in which are the remains of ancient buildings; the ſize of the ciſterns, and the conſtruction of the vaulted caves, exhibit inſtances of ancient ſplendour. South of which place is Jermah, diſtinguiſhed by numerous and majeſtic ruins, on which are many inſcriptions. Teſſouwa lies eaſtward, near which was a river which the ſhereef remembers, but is now overwhelmed in the moving ſands. N. E. from Mourzouk, diſtant about 120 miles, is the large town of Temmiſwa, where the caravans of pilgrims from Bornou and Nigritia, by way of Cairo to Mecca, provide their ſtores for the deſart.

In the town or province of Mendrah is a large quantity of *trona*, a ſpecies of foſſil alkali, that floats on the ſurface or ſettles on the banks of its ſpreading lakes, great quantity of which is ſent to Tripoli and ſhipped for Turkey, Tunis, and Morocco, at the latter place it is uſed as an ingredient in the red dye of the leather. Mendrah is about 60 miles ſouth of Fezzan. The territory of Fezzan extends but little weſtward, being confined by barren mountains. The ſmaller towns of this kingdom are ſaid to be about one hundred; theſe towns are chiefly inhabited by huſbandmen and ſhepherds; in every town a market is regularly held; mutton and goat's fleſh are ſold by the quarter, uſually from thirty-two to forty grains of gold, or from four to five ſhillings Engliſh. The fleſh of camels is dearer, and divided into ſmaller parts.

The houſes are of clay, with flat roofs compoſed of branches of trees, on which earth is laid; this is ſufficient in a climate where it never rains. The heats in ſummer from April to November, are intenſe, and the hot winds blow from the ſouth-eaſt, ſouth, and ſouth-weſt with ſuch violence, as to threaten ſuffocation; when it changes to the weſt or north-weſt a reviving freſhneſs enſues.

The dreſs of the inhabitants is like that of the Moors of Barbary, conſiſting of a large pair of trowſers, a ſhirt which hangs over the trowſers, a kind of waiſtcoat without ſleeves, and a jacket with tight ſleeves; over the jacket is a looſe robe which reaches below the knee, a girdle of crimſon, and a long cloth called a barrakan or alhaicque, like a highland plaid, is worn; ſtockings of leather laced like half boots, and ſlippers; on the head a red cap and turban, ſometimes over the whole they throw a long cloak with a hood, called a *burnooſe*. In ſummer they throw off all but the ſhirt and the cap.

The people bear very high degrees of heat, but any cold affects them ſenſibly. Their diſeaſes are chiefly the inflammatory and putrid kind; the ſmall-pox is common. Their old women are their principal phyſicians. For pains in the head they cup and bleed; for that in the limbs, they bathe in the hot lakes. They have a multitude of noxious and loathſome animals; the air is crouded with moſquitos, and their perſons are over-run with the vermin which affect the beggars of Europe.

In their perſons they incline to the negro, of a deep ſwarthy complexion, with curly black hair; they are tall, but indolent, inactive, and weak. In their common intercourſe, diſtinction of rank ſeems to be forgotten; rich and poor, maſter and man, converſe, eat, and drink together; they are, however, generous and hoſpitable.

An extenſive plain compoſes the kingdom of Fezzan, the ſoil is generally a light ſand, the ſprings are abundant, and few regions in Africa exhibit a richer vegetation. The land produces the talk, the whitethorn, date trees, the olive and lime, apricot, pomegranate and fig; Indian corn and barley are the favourite objects of cultivation, of wheat there is little raiſed. The tame animals are the ſheep, cow, goat and camel, and the wild are the oſtrich, antelopes of various kinds, one of which is called the huadee, which when chaſed, plunges with addreſs from a precipice, and lights on its hams.

The food of the lower claſs conſiſts of flour, of Indian corn ſeaſoned with oil, and fruit, thoſe of ſuperior rank eat wheat bread and fleſh. Fezzan produces much ſalt, the water has in general a mineral taſte, but the favourite beverage is a liquor from the date tree, which acquires, when fermented an intoxicating ſtrength. In religion they are rigid Mahomedans, but tolerant. Their government monarchical, their preſent king is deſcended from one of the ſhereefs of Taffilet, who about 400 years ſince obtained the crown. Till the preſent century the kingdom was independent, when the Baſhaw of Tripoli conquered and made it tributary, the reigning ſovereign has nearly thrown off this yoke. In Fezzan, the deſcendants of the prophet are highly privileged, their property and perſons are inviolable, they are exempt from certain puniſhments. This claſs are in general either princes or merchants.

The revenue is compoſed of a tax on towns and villages, a tax on every camel load of goods (except proviſions) which enters the capital, fines for offenſes, lands of perſons dying without heirs, and a tax on gardens and date trees. Gold duſt by weight is the chief medium of payment, but for convenience they are furniſhed with ſmall papers of gold duſt of different values, from two *xarbes* or one and half upwards, for ſmaller articles corn or flour are uſed as a medium. One grain of gold is equal to 1½d. ſterling. The Fezzan grain is the ſame as in England.

The juſtice of the ſovereign is highly extolled, ſmall offences are puniſhed by the baſtinado, and the puniſhments increaſe to fine, inpriſonment, and death. Truſting to their natural defence, their towns are without guard, and they have no ſtanding forces. The only war the ſhereef remembered was undertaken againſt a people inhabiting the mountains of Tibeſti, which is ſeparated from the people of Fezzan by a wide and ſandy deſart; theſe people are wild and ſavage, and had plundered a caravan belonging to the king, who ſent an army of between 3 and 4000 men againſt and ſubdued them. The country of theſe people produces much ſenna. The vales of Tibeſti are ſaid to be fertile in corn and paſture for cattle, particularly camels. They live in huts, and profeſs various religions, ſome the Mahomedan, others are attached to their ancient idolatry.

CHAP. V. *Mode of Travelling in Africa.* In the diviſion N. of the Niger, the ſeaſon for travelling begins in October, and ends in March, during this time the air is cool. In ſome places it occaſionally exhibits the phenomena of a European winter. The ſoil is ſandy, ſoft and dry. The camel is peculiarly ſuited to travel in this country, they will carry from three to four hundred weight, and the expence of carrying each hundred is about one farthing per mile, they go about three miles an hour for ſeven or eight hours a day. The caravan ſtops at the places where they find water for two days or more, to trade. The camels live on the ſmall vegetation found in the deſarts, the drivers and ſervants on camel's fleſh, milk and dates, and the meal of barley and Indian corn. The merchant carries for his own uſe the dried fleſh of camels and ſheep, and their water is preſerved in goat ſkins. The women, children and ſick are carried in a peculiar manner. Six or eight camels are yoked together in a row, many tent poles are laid upon their backs and covered with carpets, over theſe bags of corn, and over the whole other carpets, on which the traveller ſets or lies down.

A ſandy heath, covered in part with a plant called by the Arabs, Shé, reſembling the wild thyme of Egypt, conſtitutes the chief appearance of the deſarts. In ſome places thouſands of ſheep and goats paſture, in others nothing is to be ſeen but hills of ſhifting ſand, the ſun beams ſend a ſcorching heat, and the caravans are ſometimes in danger of periſhing by thirſt. No land marks appear, but the camel drivers guide themſelves by the ſun and ſtars. They croſs the river Niger in boats, which are nothing more than an ill conſtructed raft of planks faſtened together with ropes. The depth of the river at the place of paſſage, which is 100 miles ſouth of Caſhna, is about 23 or 24 feet in width, at Tombuctou it is about the ſame as the Thames at Weſtminſter. The fiſh in this river is never uſed by the natives. Having paſſed this river the caravan meets a well cultivated country, the heats are however exceſſive, and they, to avoid them, often journey in the night. South of Caſhna, for want of camels they uſe mules, horſes, and aſſes.

CHAH. VI. *Of the Empires, and of Bornou and Caſhna.* South of Fezzan lay thoſe two great empires, having a great reſemblance to each other, in ſoil, climate, laws, government, &c. From Mourſouk to Bornou the capital, is nearly a thouſand miles, the road is through many villages of blacks, whoſe looks announce their extreme miſery. The climate of Bornou has two ſeaſons; in April and the ſucceeding months, there is a deluge of rain and deſtructive thunder and lightning; during this, which laſts from three to nine days, the inhabitants confine themſelves to their dwellings: after this, till October, the heat is great, and the air becomes ſoft and mild. Near thirty languages are ſpoken in this empire. The inhabitants are all black, but not of the negro caſt; their dreſs is ſlight, and ſome of the poor have only a covering for the waiſt. Two kinds of Indian corn grow here, called gaſſob and gamphuly; horſe and kidney beans are cultivated, all by the hoe, the plough being unknown: the women labour as well as the men. Two ſpecies of roots are cultivated, the one called dondoo, is dried, and may be kept for two years; when uſed, it is reduced to a powder, and made into a paſte with palm oil; the other root is boiled for food; grapes, apricots, and pomegranates; lemons, limes, and melons, are in abundance, and a vegetable called the kedeynah, the kernel of which is eſteemed, and from the ſhell an oil is procured. Sheep, goats, cows, horſes, buffaloes, and camels, are in abundance; the Guinea fowl is reared here, bees are in great plenty; antelopes, partridges, wild ducks, and oſtriches; the fleſh of the latter is highly prized. Of wild animals they have elephants, of which they make no uſe; the hippopotamus, and an animal called the zarapah, reſembling the camel in the head and body, the neck like an oſtrich, and taller at the ſhoulders than the haunches. There are many dangerous reptiles.

In the mountains of Tibeſti the herdſmen dwell in tents, compoſed of cow hides. The houſes are ſquare, of one floor, with a court in the middle, and an incloſure round for their cattle; clay is uſed inſtead of mortar, and the walls are plaiſtered with the ſame; the roofs are compoſed of palm-tree branches and bruſh-wood, and are water-proof: their furniture and utenſils are trifling; the higher order have leathern cuſhions, carpets, and utenſils of braſs and copper; their towns are irregular. A cow is worth about ſix ſhillings Engliſh, a camel ſix or ſeven pounds, and a horſe from three to ſeven pounds. Their towns have no defence, except the capital, which has a wall and ditch.

The city is populous, the coarſer metals in pieces of different weights, ſerve for currency. The religion of Mahomet, and paganiſm, both prevail here. The monarch is elected from among the ſons of the deceaſed prince, by three elders appointed for that purpoſe; the ſon choſen enjoys two-thirds of his father's lands and cattle, and the other children the reſt. The wives of the deceaſed ſovereign have eſtabliſhments, his concubines may return to their friends. The kings are maintained by hereditary lands, and by taxes. The preſent king appears very plain; his concubines are ſaid to be five hundred, and he keeps as many horſes. His military force conſiſts chiefly of horſemen: the ſabre, lance, bow, and ſhield, are their weapons of offence and defence. The people are courteous and humane. They are fond of the game of drafts, on the event of which they will ſtake every thing that is valuable; the higher order play at cheſs. Gold duſt, ſlaves, horſes, oſtrich feathers, ſalt, and civet, are their articles of trade. Their ſlaves they procure by invading the territories of a ſavage race of negroes ſituated to the eaſt of Bergamee. They have ſalt lakes, but do not make any profit by them, permitting their neighbours of the empire of Caſhna to take it away. The civet is procured from a ſpecies of wild cat, which is taken alive in a trap, and irritated till a copious perſpiration is produced, and its ſweat being ſcraped off and preſerved, conſtitutes the perfume; this operation is renewed at times until the animal dies of the fatigue; the quantity obtained from one cat is generally half an ounce. Copper, braſs, ſilver dollars, woollen caps and cloaths, linen, and carpets, are given them in exchange for theſe commodities.

Chap. VII. *Of Caſhna.* The Fezzaners ſend an annual caravan to Caſhna. From Mourſouk they travel S. S. W. over a ſandy deſart for five days journey, then a wild uninhabited heath, then another deſart which brings them to a delightful country in which is Agadez, the moſt commercial town in the empire, the inhabitants of which are all Mahometans. After a ſtop of ten days the caravan proceeds to the ſouth, and in eight days more reaches Caſhna. The Nigritia of our modern geographers is called by the Arabs *Scudan*, and by the natives *Aafnou*, both which words mean *the land of the Blacks*; but its limits are not ſettled. The rains in Caſhna are leſs violent than in Bornou, and the manners of the people are leſs courteous. Cowries are here current, 2500 of which are equal to a mitkal of Fezzan, or about ten ſhillings and three-pence Engliſh.

The ſalt lakes are ſeparated from Agadez by a march of forty-five days, and are ſurrounded by the vaſt deſart of Bilma, the trade to thence yields a large profit. The ſenna of Agadez is very valuable. The other articles of commerce are gold duſt, ſlaves, cotton cloths, goat ſkins, ox and buffalo hides, and civet.

Chap. VIII. *Countries ſouth of the Niger.* From the Niger to the kingdom of Tonouwah, the lands are moſtly cleared; the people are chiefly ſhepherds and huſbandmen, with ſome few manufacturers of cotton cloth and dyed goat ſkins; they dwell in tents formed of the buffalo hide, and huts made of the branches of trees. The ſtates are moſtly monarchical, but there are ſome few republics: the people of this country are mild, and the Pagans and Mahometans mix indiſcriminately together. The people of the kingdom of Degombah are noted for taming the elephant, and making ſlaves of their neighbours. They have for trade, ſlaves, cotton cloth, goat ſkins, hides, and a nut called Gooroo, which is a pleaſant bitter, and by acting as a corrective to the unwholeſome waters of Fezzan is deemed of importance. Fire arms are unknown, for the inhabitants of the maritime kingdoms, to preſerve their own ſuperiority, prevent their paſſing.

CHAP. IX. *Of the trade from Fezzan to Tripoli, Bornou, Caſhna,* &c. At the end of October, when the heats are abated, the caravans depart from Mourzouk in ſmall parties of ten or twelve, unleſs in time of war; they lay in proviſions of dates, meal, and mutton ſalted, dried in the ſun, and boiled in oil or fat; the merchants have agents in the chief towns, to whom they ſend the ſlaves they purchaſe. The caravans to Tripoli carry the *trona*, ſenna, gold duſt and ſlaves brought from the ſouthern countries, and in return bring back cutlery, woollen, ſilks, dollars, copper, and braſs.

That to Bornou carries braſs and copper for the currency of the country, imperial dollars, and various manufactures, but of their own produce only a preparation of dates, and meal of Indian corn, and they take in return ſlaves, gold duſt, and civet.

To Caſhna they carry cowries, braſs to make rings and bracelets, horſes, ſeveral kinds of manufactures, and the Gooroo nuts; and in return take gold duſt, ſlaves, cotton cloth, dyed goat ſkins, hides, ſenna, and civet, for the countries ſouth of the Niger, where alſo they convey ſabre blades and Dutch knives, coral, braſs beads, looking-glaſſes, dollars, &c. and receive back gold duſt, ſlaves, cotton cloths, goat ſkins, hides, Goroo nuts, cowries, and ivory.

CHAP. X. *Rout from Mourzouk to Cairo; according to the preſent governor of Maſurata.* Fezzan communicates with Cairo and Mecca. A caravan of pilgrims proceed in the autumn of every ſecond or third year to Mecca; they proceed to Temeſſa, over the mountain of Ziltan, and thence to Sibbul, a place ſubject to Tripoli; and thence nearly in a line with the Mediterranean ſea to Cairo, and thence to Mecca by the cuſtomary rout.

CHAP. XI. From the above premiſes, the writer thinks, that concluſions of an important nature reſult. Comparing it with the account of Leo Africanus, it proves that the Mahometan faith and civilization has made ſome progreſs, and that ſouth of the Niger the ſternneſs of the Muſſelman is tempered by the mildneſs of the Negro, that the people of thoſe countries, like the natives of Bengal, uſing cowries, is a curious phenomenon; that here both the antiquarian and ſtudier of nature may find entertainment and information, and that a fine field for the improvement of commerce is opened, by means of the river Gambia, which will carry goods within 700 miles, which the Fezzaners are obliged to carry 3000.

CHAP. XII. Is a memoir, on the conſtruction of a map of Africa by Major Rennel, who obſerves, that the geography of Africa is ſo imperfect, that M. D'Anville, in conſtructing his map of Africa ſo late as the year 1749, was obliged to have recourſe to the works of Ptolemy and Edriſi, one of which wrote in the ſecond, and the other in the twelfth century. That moſt of the poſitions of the inland parts are taken from Edriſi, and that they agree nearly with thoſe furniſhed by the preſent materials.

As not one celeſtial obſervation has been taken to determine any latitude between Benin and Tripoli, all the poſitions are fixed by eſtimation, reckoning fifteen or ſixteen miles for a day's journey. Mr. Rennell places Mourzouk, the capital of Fezzan, in lat. 27°20′, or 260 miles from Maſurata; Agadez in lat. 20°20′, or 455 S. W. of Morzouk. Agadez is the Agadoſt of Edriſi.

Caſhna in lat. 16°20′ and about 1°30′ W. from Tripoli, which he ſuppoſes to be D'Anville's Caſſeenah. Caſhna he thinks may be regarded as the central kingdom of Africa.

The Niger runs S. of Caſhna, and Ben Ali was informed it is loſt in the ſand S. of Tombuctou. It is termed by the Africans *Neel il Abeed*, the River of Negroes, or *Neel il Kebeer*, the Great River.

Gonjah he ſuppoſes the Conché of D'Anville, and the Gongé of De Liſle. It is ſaid by the ſhereef to be forty-ſeven days journey from that part of the Guinea coaſt, where the Chriſtians trade, probably the Gold Coaſt. The Mahometan religion ſeems to have ſpread ſouthward to lat. 12° N.

Tombuctou, Mr. Rennel places 28 miles N. W. of D'Anville's Tombucton; Bornou about 19°40′.

From Mourſouk to Cairo the road lies through Augela, in lat. 29°20′, which is nearly midway. Augela is the Augila of Ptolemy and Pliny, and is placed by the former about 197 miles from the ſea.

Tranſactions of the Society inſtituted at London for the Encouragement of Arts, Manufactures, and Commerce; with the Premiums offered in the Year 1792. *Vol.* X.

AFTER a *Preface*, giving a general account of the Papers in the volume, and noticing the new or augmented premiums offered, the AGRICULTURAL papers begin, with the *mode of raiſing Oaks*, purſued by *Lewis Majendie, of Caſtle Hedingham, Eſq.* who obtained the gold medal offered for that purpoſe. In making his plantations, (which were in an ancient park,) "the ſoil was dug one full ſpit, and the turf inverted; the plants were two-years-old ſeedlings, removed with the greateſt care from the ſeed bed, by undermining the roots, ſo as to bring them up undamaged and entire in the ſtricteſt ſenſe: the ſubſoil of the intended plantation, being a rich tender loam, holes were bored into it with an iron inſtrument, uſed in this country for fixing hop-poles into the earth: into theſe the trees were planted, uſing great caution that each ſeedling ſhould have a hole ſuitable to the length of its tap-root, which we were careful to ſet upright, and without doubling it: the tap-roots of theſe plants were from 18 to 36 inches in length." Mr. Majendie's reaſons for not ſhortening the tap-roots of his plants were, to prevent the neceſſity of more than one tranſplantation, and to preſerve as much as poſſible, the apparent plan of nature in ordering their growth. An experiment was made at the time of forming this plantation, of ſetting apart for compariſon twelve entire and twelve tapped ſeedlings; one of each of theſe, taken up after five years, was ſent to the Society with its meaſurement. The entire rooted one had conſiderably outſtripped the other in height, but was a very little leſs in circumference cloſe to the ground. The entire had acquired a regularity of thickneſs in its general growth, and the lateral roots were moſtly fibrous: the mutilated had thrown out a number of thick horizontal roots near the place where the tap-root was ſhortened, after which the tap-root had reſumed its downward tendency in a regular manner. Atteſtations are annexed of the flouriſhing ſtate of the plantations at the time of examination.

The next paper relates to the plantations of *Mixed Timber Trees*, for which the gold medal was adjudged to *John Holliday, of Dilhorn, Staffordſhire,* *Eſq.*

By the liſt annexed, the numbers and kinds are as follow.

Oaks - - - - - -	10,000	Black Italian ditto - -	100
Evergreen Oaks - - -	500	Weeping Willows - -	50
White Spruce - - -	600	Hemlock Spruce - -	25
Beech - - - - - -	94,000	Cypreſs - - - - - -	25
Larch - - - - - -	7,900	White Spruce - - -	200
Lombardy Poplars -	100		
		In all	113,500

The method uſed in making the Plantations was, with reſpect to the Beech, by digging a roundiſh hole, about the diameter of two ſpades, preſerving the beſt turf, and placing it on the ſouth-weſt; which, by experience, has been found to anſwer two uſeful purpoſes, firſt, that of protecting the young plant from our greateſt ſtorms in winter; ſecondly, in ſhedding the beſt ſoil in the bed of the hole, both winter and ſummer. The nature of the Beech ſoil is light, with ſharp gravel; of the oaks, fine deep clay.

Nathaniel Kent, Eſq. next gives a communication reſpecting the uſes and value of the Cheſnut tree. He confirms Mr. Majendie's account of this tree, in the 9th Vol. of *Tranſactions*, repreſenting it as unequalled for hop-poles and ſtakes, gates, poſts, and building-timber. He gives various inſtances of its durability, proving its ſuperiority to oak in that reſpect; and he accounts for the character given it by Evelyn, of being ſubject to rot at the heart while it has a fair outward appearance, by ſuppoſing it to have been applied to cheſnut ſuffered to ſtand too long, when it really deſerves that imputation. Whereas it is a circumſtance which gives peculiar value to this wood, that it can never be taken too young, provided it be of the ſize required; its durability at an early age being owing to the very ſmall proportion of its ſap, compared with that of other trees.

William Pattenſon, of Ibornden in Kent, Eſq. gives an account of his making two plantations, both together containing ſeven acres and a half, of the Upland or Red Willow, 1742 plants to an acre, for which the gold medal premium was adjudged to him.

Sam. Dunn, Eſq. whoſe account of an experiment made on one acre and a half of land, cultivated with Potatoes, inſtead of lying under a ſummer fallow, was inſerted in Vol. IX. of the *Tranſactions*, tranſmits a ſtatement of the advantages derived from that practice. The wheat when threſhed produced 8½ quarters of clean corn, value, including the ſtraw, 20l. 1s. 6d. Expences attending its growth, 6l. 7s. 3d. Clear profit, 13l. 14s. 3d.

Mr. Thomas Rogerſon, of Narborough, communicates a ſtate of the comparative advantages of the Drill and Broad-caſt method in the culture of Wheat. In a field of 48 acres, of which 21 were drilled, and 27 ſowed broad-caſt, the crop turned out in favour of the drill to the amount of 3s. 1½ per acre. Nothing deciſive is ſtated as to another experiment in which both drilling and broad-caſt were tried in various modes; but it appears that early drilling, eſpecially on light ſoils, is preferable to late.

Another compariſon of the ſame kind is related by *Mr. Peter Smith, of Hornchurch, Eſſex,* to whom the premium for that purpoſe was adjudged. A twelve acre piece of a mixed ſoil or gravelly loam was laid down as a wheat fallow, and ſown in October, 1790, half in the broad-caſt way, with 2½ buſhels of ſeed per acre; (each buſhel, 8 gallons, three quarts;) the other half by Cooke's drill, with one buſhel per acre. The drilled part was injured by the rooks, and by a flood which hindered the operation of ſcarifying ſo ſoon as it ſhould have been done. During winter the broad-caſt looked by much the beſt, but in March the drilled got the lead and kept it. The broad-caſt was the firſt ripe, but the drilled was cut immediately after it. Both crops were thraſhed by the ſame men with great exactneſs. The produce of the drilled was 25 quarters 6 buſhels; that of the broad-caſt, 24 quarters 1½ buſhel. The acre of drilled, therefore, exceeded the acre of broad-caſt, two buſhels, four quarts, which, with the ſaving of ſeed, amounts to 3½ buſhels, 4 quarts, value about 20s. per acre, in favour of the drill. This advantage was trifling compared with the benefit the land has received from being ſcarified and horſehoed, which was very viſible when the crops were cut, the drilled ſtubble being very clean, the broad-caſt foul. The expence of both methods was nearly the ſame. The broad-caſt had a hand-hoeing, which it is not uſual to give wheat in that part of the country. On the whole, Mr. Smith is ſo much convinced of the ſuperiority of the drill, that he has ſince drilled all his wheat, viz. 40 acres.

Mr. William Dann, of Gillingham, Kent, gives an account of experiments to determine the comparative advantages of the drill and broad-caſt method of cultivating turneps. The firſt was upon ſeven acres of thin, light, ſtony land, on a chalk bottom, worth 11 or 12s. per acre, prepared for turneps by four ploughings with harrowing and rolling. Some graſs burnt upon the land produced 24 cart-loads of aſhes, which were ſpread on four acres. The whole ſeven were alſo manured with compoſt, ſomewhat leſs being laid on the part where the aſhes were ſpread. The field was ſown on July 8th. in ſtripes, ſo as to give to each ſtripe a part of the land manured in both ways; three acres were ſown broad-caſt with five quarts of ſeed; the remainder were drilled with four quarts, the drills 10½ inches aſunder. About the end of Auguſt a difference was firſt perceived in favour of the drilled. On December 6, five perches of each, taken as nearly equal as poſſible, were weighed; the ſum of the broad-caſt was 1345lb; of the drilled 1430lb: difference, per perch, 17lb: per acre, 1 ton 4cwt. 1qr. 4lb.

The experiment was repeated on ſeven acres more, prepared nearly as above, except that no aſhes were uſed, but on better land, being a good friable loam, worth 17 or 18s. per acre. Nearly two quarts of ſeed per acre were ſown broad-caſt, and one in the drill, on July 17. On November 29, four perches of each, impartially ſelected on different parts of the land were weighed, when the amount of the broad-caſt was 1278lb; of the drilled, 1405lb; difference per perch 31¾lb; per acre, 2 ton, 5cwt. 1qr. 12lb. The reſult of two other experiments was, in favour of the drill, in one, at the rate of three tons per acre; in the other, of 1 ton 3cwt. 2qr. 8lb.

Mr. John Ambroſe, of Copford, near Colcheſter, obtained the premium for experiments on the comparative advantages of the drill and broad-caſt method in cultivating turneps, and gives the following account of them. Two pieces of land, of a ſimilar good, mixed, middling, dry ſoil, were ſown in the beginning of July, 1791, after being manured and tilled alike, with turneps, one broad-caſt, the other with Cooke's drill-machine. The drilled were twice horſe-hoed and once hand-hoed, at the expence of 4s. 6d. per acre; the broad-caſt were twice hand-hoed, at 6s. 9d. per acre. On December 26, ten rods of each, taken one at the diſtance of every five rods, were weighed with great care. The drilled produced 1 ton, 9 cwt. 2 qrs. 8 lb.; the broad-caſt, 1 ton, 7 cwt. 3 qrs. 1 lb.: difference per acre, 1 ton, 12 cwt. 2 qrs. 8 lb. By a calculation of value, including the expence ſaved in hoeing, the drilled have a a preference of 6s. 3¾d. per acre.

Mr. Ambroſe further informs the Society, that he has drilled turneps for the two laſt ſeaſons, and alſo grain for the laſt three years. Laſt autumn he had drilled upwards of 120 acres of wheat; and he has likewiſe drilled all his peas and beans.

Mr. William Dann has the thanks of the Society for his further information reſpecting the drilling of turneps and wheat; which is, that he has this year drilled the whole of his turneps with great ſucceſs; and that an experiment of half an acre of wheat drilled at ſeven inches, compared with the ſame quantity broad-caſt, gave two buſhels, ſix quarts, per acre, in favour of the drilled.

He then gives an account of his cultivation of potatoes for feeding cattle and ſheep. Five pieces of ground were planted with potatoes, the expences and produce of which are thus ſtated.

RECAPITULATION.

	Quantity of ground.			Expence.			Produce.	OBSERVATIONS.
No.	*A.*	*R.*	*P.*	£.	*s.*	*d.*	Buſhels.	
I.	2	0	0	10	8	4	687	By this account, it appears that the prime coſt of the potatoes was 1*l.* 12*s.* 2½*d.* more than 5*d.* per buſhel; but the whole charge of the manure is included, the half of which might very fairly be carried to ſucceeding crops, and would conſequently reduce the price greatly. They were cultivated with the ſole view of feeding cattle and ſheep with them; but, for the reaſons hereafter ſtated, about a tenth part were ſold.
II.	2	3	0	16	3	1½	1298	
III.	0	3	0	3	18	11½	196	
IV.	2	1	20	13	17	10½	877	
V.	2	0	0	7	8	4	674	
Total	9	3	20	51	16	7½	3732	
My bailiff's account for digging, picking up, carting home, and ſtowing away				27	10	7		
Total expence				79	7	2½		

The Potatoes were applied as follow.---To ſeventeen Bullocks.

No.	When. bought.	When ſold	Days kept.	Expences of keeping, at 11*d*. per day.	Prime-coſt.	Sold for.	Gain by each.
	1790	1791		£. *s*. *d*.	£. *s*. *d*.	£. *s*. *d*.	£. *s*. *d*.
1	Nov. 8	Mar. 24	136	6 4 8	17 16 6	25 4 5	7 7 11
2	do.	Feb. 24	108	4 19 0	15 11 6	20 9 7	4 8 1
3	do.	Mar. 3	115	5 5 5	15 11 6	21 13 7	6 2 1
4	do.	Apr. 1	144	6 12 0	14 6 6	21 15 2	7 8 8
5	Dec. 11	Mar. 10	89	4 1 7	16 11 6	20 9 7	3 18 1
6	do.	—— 17	96	4 8 0	18 1 6	23 14 5	5 12 11
7	do.	Apr. 22	132	6 1 0	16 11 6	22 7 8	5 15 8
8	do.	—— 8	118	5 8 2	16 1 6	20 17 7	4 16 1
9	do.	—— 15	125	5 14 7	16 1 6	19 16 4	3 14 10
10	Oct. 30	Mar. 25	146	6 13 10	11 0 6	19 13 7	8 13 1
11	Nov. 27	Jan. 19	53	2 8 7	14 11 6	16 10 0	1 18 6
12	do.	do.	53	2 8 7	13 0 0	15 0 0	2 0 0
	1791						
13	Jan. 22	Apr. 22	83	3 16 1	19 11 6	24 2 0	4 10 6
14	do.	do.	83	3 16 1	19 11 6	24 11 6	5 0 0
			1481	67 17 7	224 8 6	296 4 11	71 16 5

Observations.

Each ox eat one buſhel and a half of potatoes a day, which I value at 6*d*. per buſhel, and eight pounds of hay, value 2*d*. together 11*d*. a day. No. 9 was very poor when bought; from which I conclude that cattle, put to potatoes in a low ſtate, will not pay ſo well as when they are a little forwarder in fleſh.

The following is ſuppoſed profit, as they were part of my own ſtock; the firſt a heifer, the other two working oxen, very poor, put up for experiment, to prove if potatoes would anſwer for oxen in that ſtate. I think they do not; for, according to my eſtimate, they did not pay more than 4l. 10s. each, for keeping 134 days.

No.	When bought.	When ſold.	Days kept.	Expence of keeping, at 11*d*. per day.	Prime-coſt.	Sold for.	Gain by each.
				£. *s*. *d*.	£. *s*. *d*.	£. *s*. *d*.	£. *s*. *d*.
15	Nov. 1	Jan. 12	73	——	——	——	2 10 0
16	Dec. 28	May 10	134	——	——	——	4 10 0
17	do.	do.	134	——	——	——	4 10 0

Total days kept - 1822 which, at 1½ buſhel, is 2733 buſhels eat by bullocks.

Observations.

The potatoes to both ſheep and oxen were given unwaſhed, but the earth was moſtly rubbed off from them, when they were picked up; and ſome were cut for the ſheep.

He alſo put up ſix four-years old Wiltſhire wether ſheep to potatoes on Nov. 18, 1790, and gave them no other food. It was near three weeks before they would eat them, having firſt devoured the ſtraw they were littered with, and the thatch from the ſhed; whence they were worſe at the expiration of that time, than when firſt put up; on which account he makes no charge for potatoes till fourteen days after. They were ſold on March 26, 1791, at full 10s. each more than they were worth when put up. Each eat about 8 lb. per day, which, for 114 days, is about 75 buſhels. The whole conſumed by cattle and ſheep is 2808 buſhels. The remainder were given to his working horſes, oxen, cows, &c. except 367 buſhels that were ſold late in the ſpring, and 320 buſhels cut to plant. He obſerves, that a greater immediate profit would have ariſen from ſelling the potatoes, than feeding cattle with them; but he conceives that the manure made by the latter is nearly equal to the difference.

In a ſubſequent letter, Mr. Dann remarks, that his ſtated charge of 6d. per buſhel for the potatoes on which his cattle were fed, was nearly a penny more than the whole expence of raiſing them, with the land left in an improved ſtate; that the hay, though indifferent, is charged at 2l. 2s. per load; and that though the difference between the coſt of feeding and the grain appears ſmall, it is proved that each ox increaſed in value one ſhilling per day by potatoes, which is proving a great deal. He further adds, that he conceives there ſhould be added to the profit, 12l. 10s. for 250 loads of dung. The hay given was in equal portions, at noon and night: they were twice in the day looſed to drink, but in general drank little. Strict orders were given that no potatoes ſhould be left in the trough at night, for twice or thrice an ox was nearly choaked with a potatoe; on which account a large ſtiff rope was always in readineſs to force down the throat. He made no charge for attendance, as he conſidered the improvement of 15 pigs ſupported on the refuſe of the oxen-troughs, as an adequate recompence.

A third letter mentions his having carried into effect an idea before noticed, of keeping a reſerve of potatoes for ewes and lambs in the ſpring, that turneps may not remain to exhauſt the land, and injure future crops. He brought the ſheep to eat potatoes, by ſliceing ſome into the troughs before the turneps were finiſhed. From April the 2d to the 14th, he kept 156 ewes, and 155 lambs in a meadow of 5¼ acres, on potatoes and clover hay. They eat each day of potatoes 616lb. of hay 279. Although this period was ſhort, it was highly valuable, as there was very little clover when the turneps were finiſhed, and feeding it ſo young would have injured its after-growth.

John Hunter, Eſq. of Gublins, Hertfordſhire, communicates to the Society his ſucceſs in feeding cattle with potatoes, a practice he has purſued for two years. The laſt year he fattened 103 oxen principally with that food; and he has at preſent 70 capital cattle feeding upon it. Potatoes, however, though wonderfully nutritive, will not fatten oxen in a reaſonable time without hay. Mr. Hunter's advice as to their culture is as follows. After any crop of the former year, plough your land in boughts, to be bit by the froſt, and make it ready to receive the crop in April. Sow then the eyes of Potatoes in lines, following the plough, and leave a ſpace between each furrow of about four feet, in order that the plough may paſs to kill weeds in ſummer, and turn the mould up to the root of the haulm on either ſide, going up and down. From proceeding thus, you will not fail in any dripping year of 200 buſhels to an acre. But the greateſt advantage is, that the crop has ſo cleaned and meliorated the land, equal to any ſummer fallow, that it becomes perfectly fit in good time to ſow wheat.

Sir William Fordyce, M.D. F.R.S. had the premium adjudged to him for cultivating rhubarb, of which, as appears by his letter and certificates, he had upwards of 300 flouriſhing plants growing at Brompton in October 1791.

Mr. G. Poynter, of Canewden, near Rochford, Eſſex, obtained the premium offered for gaining land from the ſea, and gives the following account of his operations. Having hired a farm in *Wallis's iſland,* which is formed by two branches of the river Crouch, and the German Ocean, he determined upon the encloſure of part of the *Saltings* attached to the farm, which were then overflowed by the ſea. Having engaged ſeventeen perſons as wallers, he began to embank on March 22, 1790, by making a delf-ditch, twelve feet wide. The ſeat of the wall is twenty-one feet wide, ſix feet high, and five feet wide on the top. Its length is two hundred and eighty-ſix rods, at twenty feet to the rod. On July 17, 1790, the new wall was completed, giving him poſſeſſion of ſeventy acres and upwards of land, equal in quality to any in the iſland. This new embankment had the additional merit of ſaving all Wallis's iſland (which is in high cultivation) from being inundated by the extraordinary high tide in February 1791. By the account of expences annexed, it appears that the charge of making the wall was 20s. per rod, amounting to 286l. and the total expence was 344l. 2s.

A ſecond letter from Mr. Poynter mentions, that about four months after the wall was completely finiſhed, he had the top of it rolled with a very heavy ſtone roller, drawn by four horſes, for the ſpace of eight or nine months, whereby the work was greatly conſolidated, and fitted to withſtand the tide. At the ſame time he ſowed the inner part of it with twitch and rye-graſs, which throve well, and by their entwining roots ſerved to ſtrengthen the bank, beſides affording paſturage for his cattle.

John Keyſal, Eſq. of Morton-upon-Lugg, near Hereford, gives the following account of the improvements made upon his eſtate by draining, for which he obtained the Society's premium of a gold medal.

"In November, 1789, I bought the eſtate; and, ſoon after that period, I went over it with my ſteward, Mr. Wainewright, who is a land-ſurveyor, at Hereford, and found that the land, though good in its nature, was rendered of ſmall value, from its being often overflowed; and inſtead of producing good graſs for feeding and mowing, was almoſt covered with ſedges and ruſhes.

"We then conſidered what method ought to be adopted for the improvement of it; and it appeared to us, that nothing could remedy the evil, but draining. The firſt ſtep was to take a level, in order to find out the loweſt part; and as no perſon in that country had been uſed to a buſineſs of this kind I ſent for a man out of Staffordſhire, who had been employed there by the proprietors of canals.

"The firſt thing he adviſed, was, to cut a large open drain through the whole of the land; which was ordered to be done, being about one mile and a half long; the lower part of which is nine feet wide, and ſeven feet deep; and the upper part, five feet wide, and about four feet deep; which occaſioned a fall for the water to run off, and prevented its being pounded up.*

"By this means we were alſo enabled to procure a fall for the under drains to empty themſelves into: beſides this, we cut ſeveral other large open drains, not only acroſs the land, but alſo one on each ſide the boundary of the eſtate, which has had the effect, not only of improving my own land, but alſo a conſiderable quantity of other people's adjoining thereto; and, I flatter myſelf, the truth of what I aſſert is ſo viſible, that it will induce others to adopt the like method of improvement. Some gentlemen have, indeed, already begun ſo to do.

"Another great uſe of the large open drain, is, that the river Lugg, which bounds the one end of my eſtate, often overflows; and from the meadows being lower than its banks, and the whole courſes nearly filled up, the water could not return, but remained on the land; but by this new cut it is now taken off.

"This, though a very expenſive work, did but in part effect the remedy; and although the land was much improved near the drains, that at a diſtance did not reap an equal benefit: it was then we were determined to have under-drains cut where they were neceſſary: we ſurveyed the land; and wherever the water forced its paſſage to the ſurface of the earth, and thereby prevented the growth of graſs or corn, we cut under-drains, to the quantity laid before the ſociety; and by that means have now made the whole perfectly dry and ſound, and of nearly double the value it was before.

"The

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* My drain runs into other drains, which, at a conſiderable diſtance, diſcharge themſelves into the river.

that place, the under ſtrata altered their poſition; the quickſand which conveyed the water, now became of twice its former thickneſs; and the clay which had hitherto been above that quick ſand for ſome diſtance, diſappeared. From the quick ſand thus becoming ſo much deeper, we could not, with the level of the mill-pool, cut through it; nor, indeed, from the wetneſs of the ſeaſon (November 1791), would ſuch an operation have been proper. I therefore continued a ſhallow drain to ſome diſtance making ſide holes into the quick ſand, which ran freely; but as this could not cure the whole of the bog below, we branched out another drain, which was made by the method deſcribed for curing the ſecond claſs of wet or boggy land, by ſinking a cloſe drain, through the upper ſtrata, into the upper clay, and then, at a ſmall diſtance, on one ſide of this cloſe drain, boring a hole, with an auger, through the remaining part of that clay into the quick ſand, and, at every eight yards, as this cloſe drain advanced, ſtill boring other holes, in the ſame manner as before deſcribed: through many of theſe holes, the water ruſhed with great rapidity. The water diſcharged by theſe drains into the mill-pool, is one hundred and ſixty eight gallons per minute, or three thouſand ſeven hundred and eighty hogſheads in a day, which is after the rate of one million three hundred and ſeventy-nine thouſand ſeven hundred hogſheads in a year.

" About ſix acres of this land were always ſound; about twelve acres on the north ſide were an abſolute pulp, and the remaining twenty-ſix acres very unſound.---The whole is now ſound, and will, when cultivated, be worth ſixteen ſhillings per acre. This land would have been drained at a much leſs expence, into the main open drain; but then the water, which was much wanted for the mill, would have been loſt. Theſe cloſe drains are in length one thouſand four hundred and fifty-two yards, and coſt one hundred pounds, of which about thirty pounds ought to be charged to the mill.

CHEMISTRY.

THE *Rev. Mr. Swayne, of Puckle-church, near Briſtol,* communicates the reſult of an experiment relative to the quantity of aſtringent matter contained in oak-leaves, with the view of their being employed as a ſubſtitute to oak-bark in tanning. The method he took to form an eſtimate for this purpoſe, was to aſcertain the quantity of extractive matter thrown down from a decoction of oak-leaves, and of oak-bark, by the addition of a certain quantity of martial vitriol. He firſt aſcertained the weight of iron in a given weight of vitriol, by precipitating it from a ſolution in water with the addition of fixed alkali. Next, he made a decoction of half a peck of dried oak leaves, which, after extraction of all the ſoluble matter, he evaporated down to one gallon. In the ſame manner he treated two pounds of dry oak-bark. In a given meaſure of theſe decoctions, he diſſolved five pennyweights of green vitriol, and as much fixed alkali. The purpoſe of this laſt addition was to deſtroy the acid of the vitriol, which, from its cloſe attachment to the coloured particles, would otherwiſe carry them with it through the filtre. This mixture he ſet to filter; and the colouring matter all remaining in the filtre, it was well elutriated by effuſions of water. It was then dried, and weighed. The weights of the filtre, and of the iron (as above aſcertained) being ſubſtracted, the extractive matter from the leaves appeared to be 1 dwt. 1 gr.; that from the bark, 2 dwt. 2 gr. Each of the decoctions was further evaporated to half their meaſure, and the ſame experiment was tried with them; when that of the leaves yielded 1 dwt. 21 gr. that of the bark, 4 dwt. 8 gr. From theſe reſults Mr. Swayne infers, that half a peck of oak-leaves contain nearly as much aſtringent matter as one pound of bark; and calculating the preſent prices at which each may be had, he ſuppoſes that the tanner might obtain as much of that matter from leaves that coſt him fourpence, as from bark of five times that price. But whether from other circumſtances it would anſwer the ſame purpoſe to him, he does not determine. The advantage of uſing leaves inſtead of bark is obvious in the preſervation of oak-trees, which are now cut down very young, on account of the value of the bark.

PAPER IN POLITE ARTS.

IN the 5th vol. of *Tranſactions*, an account is given of a method of painting in wax, in imitation of the ancient encauſtic, by *Miſs Greenland.* That lady now communicates to the Society her method of uniting wax and maſtich with water, to ſerve as a vehicle for the colours uſed in this mode of painting.

" Put into a glazed earthen veſſel, four ounces and a half of gum arabic, and eight ounces of cold ſpring water: when the gum is diſſolved, ſtir in ſeven ounces of gum maſtich, which has been firſt waſhed, dried, picked, and beaten fine, which is very ſoon done: ſet the earthen veſſel, containing the gum water and gum maſtich, over a moderate fire, continually ſtirring and beating them hard with a ſpoon, in order to diſſolve the gum maſtich: when ſufficiently boiled, it will no longer appear tranſparent, and will be ſtiff, like a paſte. So ſoon as this is the caſe, and that the gum water and maſtich are quite boiling, without taking them off the fire, add five ounces of white wax, broken into ſmall pieces, ſtirring and beating the different ingredients together, till the wax is perfectly melted, and has boiled: then take the compoſition off the fire; as boiling it longer than neceſſary, would only harden the wax, and prevent its mixing ſo well afterwards with water. When the compoſition is taken off the fire, and in the glazed earthen veſſel, it ſhould be beaten hard; and, whilſt hot, but not boiling, mix with it, by degrees, ſixteen ounces of cold ſpring water; then ſtrain the compoſition, as ſome dirt will boil out of the gum maſtich, and put it into bottles.

" The compoſition, if properly made, ſhould be like a cream, and the colours, when mixed with it, as ſmooth as if with oil. The method of uſing it, is, mixing the colours with it as with oil; then paint with fair water. The colours, if grown dry, when mixed with the compoſition, may be uſed by putting a little fair water over them; but it is leſs trouble to put ſome water, when the colours are obſerved to be growing dry.

" In painting with this compoſition, the colours blend without difficulty, when wet; and even when dry, the tints may eaſily be united by means of a bruſh, and a very ſmall quantity of fair water.

" When the painting is finiſhed, put ſome white wax into a glazed earthen veſſel, over near the edge of the great bog: in the firſt operation, we dug through the peat, the hard ſand, and gravel, and one ſpade's graft (about nine inches deep, and ſeven inches wide) into the quick ſand, the whole length of this drain, which is ſeventy-three perches of eight yards to the perch in length. The drain thus dug, ran copiouſly, not leſs than ſixty gallons per minute: in this ſtate I left it about nine days; the effect of it was rapid, both above the drain, and on the bog below. Upon examination, I now found about three inches on the top of the ſpade's graft, which had been made into the quick ſand perfectly dry: we then dug out this three inches of dry ſand, to nearly the whole width of the drain, three feet; and at the ſame time dug out, as before, another ſpade's graft from the top of the quick ſand, as near the middle of the drain as poſſible: this was left to run a few days as before, and had the ſame effect, namely, three or four inches more of the top of the quick ſand became dry and hard: the ſame operation was repeated again and again, with the ſame effect, till the purpoſe of getting through this quick ſand was completed, ſo far at leaſt as the level of the main open drain would permit. The ſtream of water continued increaſing during the whole operation: the bog below the drain was quite dry, and the land above perfectly ſo: the drain which was firſt made, and continued running for ſome time, during the progreſs of the main cloſe drain, became gradually dry; and has not, ſince that drain was finiſhed, diſcharged one ſingle drop of water. Great care was neceſſary in making the main cloſe drain to keep the ſtream of water in the *middle* of it, otherwiſe the current would have undermined the ſides, as it ſometimes had done, and cauſed them to fall in: for this reaſon, it was neceſſary, when the dry ſand was taken from the top of the quick ſand, *immediately* to take out a ſpade's graft from the *middle* thereof, in order to divert the current from the ſides.

" The main cloſe drain thus made, was three feet wide at top, about nine feet deep on the average; and bevelling a little from the top, it was about one foot ten inches wide at bottom. The ſtone and other materials were put into this drain in the following manner.

" Where the drain went through the quick ſand into the ſtratum of clay below it, as in moſt places it did, the bottom, and in ſome inſtances the ſides, wanted no particular ſecurity; but where it did not go quite through the quick ſand, which the level of my main open drain in ſome places would not admit, the bottom of the drain was covered half an inch thick with ling; then peat-turfs, one foot wide, and three or four inches thick, were cut in convenient lengths, and placed on their edges, on each ſide the bottom of the drain, forming two ſides of a trough of peat: then ſide ſtones, about eight inches high, and a ſtone coverer, were put in upon the ling, between the peat turfs: a large peat turf, near two feet wide and four inches thick, was then cut and firmly placed over the whole: this left, in the bottom of the drain, an open ſpace of more than ſix inches ſquare, for the water to paſs. The whole was then completed by filling-in the upper part of the drain.

" Fifteen acres are now plowed for a fallow: the bog (nine acres) will now bear a horſe; but as it was, before draining, quite a pulp, I ſhall let it harden during the next ſummer, before it is ploughed.

" Another part of the bog is laid dry in the ſame manner as that before deſcribed, by drains; with this difference, that the quick ſand lay nearer the ſurface of the land, and was much thinner: therefore the drain went through it ſo far into the clay, as to render ſide-turfs in moſt places unneceſſary, its depth on the average not being more than five feet: the laſt-deſcribed land, about eight acres, I intend to plough in March for oats. I have this day, the 20th of January, 1792, meaſured the quantity of water diſcharged through theſe drains, by ſinking a hole near the ſide of the main open drain, and placing a caſk of known dimenſions therein, and find the diſcharge to be $50\frac{4}{10}$ gallons in one minute, or 72,576 gallons in twenty-four hours. The land, thus drained, will, with proper cultivation, be worth at leaſt fourteen ſhillings per acre. The draining of theſe thirty acres of land coſt me about eighty pounds, excluſive of the ſuperfluous drain. The whole length of theſe cloſe drains, is ſixteen hundred and fifty-five yards.

" I have alſo hollow drained nine acres of my farm, in the bottoms of three pieces of encloſed land, called Small Leafield, Old Land, and Holywell, by the method preſcribed for the third claſs of wet land. Theſe drains were made a few yards below that part of each field where the dry and wet land ſeparate, about twenty-two inches deep, with ſides, and a coverer of ſtone, and ling on the top of it, to keep the earth from running in. The length of theſe drains is eight hundred and eighty yards, and the expence of labour and materials, three half-pence per yard: the drains, in wet weather, diſcharge a large quantity of water, and will, I have no doubt, anſwer the intended purpoſe.---Thus far relates to land in my own occupation.

Nine acres of the land, in the Earl of Aylesford's own occupation, was almoſt an entire pulp. This bog was of the ſecond claſs, namely, water paſſed through a quick ſand, and confined by a ſtratum of clay below, and another ſtratum of clay above it. The water thus confined, by being preſſed by its fountain, and forced up through the weakeſt parts of the clay, had formed a bog of irregular thickneſs, on the ſurface, in ſome places, ſix feet deep, and in others not more than two. As there is a conſiderable fall in this land, from eaſt to weſt, I thought it expedient to put two drains into it; and this appears to me to have been neceſſary, from a conſideration that both theſe drains continue to run in the ſame proportions as when firſt opened. The manner in which theſe drains were executed, was, by digging through the different upper ſtrata, and as deep into the clay as the main open drain would admit; then digging or boring through the remaining part of that clay into the quick ſand, at the diſtance of about ſix yards, in a progreſſive manner.

" The water riſing rapidly, through theſe holes, into the cloſe drains, has effected a compleat cure of this land, every part of which will now bear a horſe to gallop upon it. Theſe drains diſcharge three thouſand ſix hundred and ſixty gallons an hour, which is much leſs than they did at firſt, as muſt be the caſe in all bogs. This land will be worth twenty ſhillings per acre. The draining coſts twenty-five pounds: and the length of the under-ground drains is eight hundred and fourteen yards.

" I have juſt now finiſhed draining another piece of land, about forty three acres; and as this was intended to anſwer two purpoſes, one to drain the land, and the other to give an additional ſupply of water to a mill pool; and, as a circumſtance aroſe in the execution of this work, which frequently happens in draining land, namely, a ſudden alteration in the poſition of the under ſtrata, a deſcription thereof will not, I hope, be thought tedious. This draining was begun at the level of a mill-pool, and continued without any great difficulty to the diſtance of about thirty-two chains, in the manner before deſcribed as a cure for the ſecond claſs of boggy land: but, at or near that

"In every country there are large portions of land that, in wet ſeaſons, have always what may be called a dry ſurface, and other portions of land that have always a moiſt or wet ſurface: the former of thoſe admitting all the water which falls upon them, to ſink freely through their pores, to various depths, till falling on clay or ſome other unctuous earth, whoſe pores will not permit it to paſs through, it is there held up, to a height proportioned to the quantity of water which comes upon it, and the facility with which that water is diſcharged: thus held up to various heights, it ſerves as a fountain to diſtribute its water (either by veins of ſand, pebbles, or rocks), according to the formation of the different under-ſtrata on the neighbouring lands, and there forms bogs and other varieties of wet ſurface, on a baſis that will, I believe, be always found to conſiſt of marl, clay, or ſome mixture thereof. The effect of water thus diſtributed, may be divided into two claſſes.—The firſt claſs, where the water is thrown out by a body of marl or clay, &c. upon the ſurface of deſcending ground, and in the value (there held up by clay alſo), forms bogs or ſwamps: the ſecond claſs, where the water is held up by clay or marl, as before, having, above that marl or clay, a ſtratum of ſand or pebbles, through which the water paſſes; and, above thoſe ſands, or pebbles, another ſtratum of marl or clay, through the weakeſt parts of which, the water, by a continual preſſure from its fountain, forces a paſſage upward; and thus, through the weakeſt parts of the marl or clay, furniſhes a continual ſupply of water, on the ſurface, for the formation or growth of bogs, &c. in proportion as this water is more or leſs abundantly ſupplied by its fountain or head, namely, the higher lands, in which rain-water freely paſſes, as before deſcribed. There are alſo different ſoils, under different circumſtances, which may form a third claſs of land for draining; ſuch as ſtrong deep ſoils, or open light ſoils, having near the ſurface a body of marl or clay: in either of theſe caſes, the water which falls on the ſurface muſt, for reaſons which are ſelf-evident, keep ſuch lands, in rainy ſeaſons, conſtantly wet and cold; and it ſhould be obſerved, that a mixture of all the three before-deſcribed claſſes of wet land, ſometimes occur in one field, by ſudden alterations of the under-ſtrata, and thereby perplex the operator, by requiring all the different modes of draining in the ſame field.

If it be admitted that bogs are thus formed and fed, their cure may be effected with certainty.—The firſt claſs, by cutting through the ſtratum (be it ſand, pebbles, or rock) that conveys the water to the bog, and carrying off that water by a cloſe drain, to ſome proper place, where the level admits of its diſcharge: the ſecond claſs, by ſinking a drain to any convenient depth in the upper clay; then, at a ſmall diſtance, on one ſide of this drain, dig, or, with a large auger, bore through the remaining part, be it (the upper clay) ever ſo deep, into the under-ſtratum of ſand, pebbles, or rock, through which the water paſſes; and it will then ruſh up into the drain ſo made, with a velocity proportioned to the height of the land, or fountain, from whence it is ſupplied. As this drain advances through the land, holes muſt be dug or bored, as before, every ſeven yards, or at ſuch diſtance as the ſtrength of the ſprings may require; and the whole of the water thus brought up by tapping the ſprings, is carried off by the drain, made in the upper clay, which muſt be a cloſe one, to its proper level, and there diſcharged.

By both theſe methods of draining, large tracts of land, under favourable circumſtances, may be cured with one drain. The beſt place for fixing theſe drains, is where the ſtratum that conveys the water comes neareſt to the ſurface; and the beſt method of aſcertaining that, is to bore, or dig, in different parts, through the different under-ſtrata.

" The third claſs may be eaſily cured by cloſe drains, at ſuch diſtances and depths as will beſt carry off the ſurface water. It may not be improper to obſerve, that where the different ſtrata or meaſures *crop out*, that is, become gradually more and more ſhallow in ſome certain direction, as is often the caſe, till, one after the other, they all preſent themſelves in ſucceſſion, on the ſurface of the earth; in ſuch caſes draining may often be much more eaſily and better effected by croſſing, with the drain, the different ſtrata or meaſures, where the levels and other circumſtances will admit.

" Some of the land drained, was part of a common, in the pariſh of Church Bickenhill, in the county of Warwick: a part of it was covered with moſs and ling, has a peaty ſurface, about ſix inches deep, and produced little or no graſs. In all wet ſeaſons, it was filled quite to the ſurface, and often overflowing with water. Some of the land was much more unſound, deeper of peat, and covered with moſs in moſt parts, nine inches long; another part was an abſolute bog in all ſeaſons.

" Having dug or bored, with a large auger, into ſeveral parts of the land, I found peat, gravel, and ſand, mixed, and a quick ſand almoſt uniformly. The quick ſand, in every part, after getting an inch or two into it, ſeemed almoſt as fluid as water; judging from thence that no materials for a drain could be laid in the quick ſand, but what it would immediately bury, I dug a trench almoſt to the quick ſand, leaving gravel, &c. of ſufficient ſtrength to bear up the materials for a hollow drain: theſe materials were two ſides and a coverer of ſtone, with a peat turf on the top, to keep out the ſoil. At every ſeven yards forward, by the ſide of this drain, I dug a hole into the quick ſand, as deep as it would permit; from theſe holes the water roſe freely into the hollow drain, and was by it diſcharged at a proper level. It may be proper to remark, that the ſtone made uſe of for this drain, and all others here mentioned, is a red ſand and rag ſtone, from Meriden quarry, about four miles from this place, which eaſily ſplits into proper ſizes for the purpoſe, and is very durable: it coſts about ſixpence per ton getting, excluſive of carriage. The drain thus formed, ran on the whole rather freely, and made the land dry for a few yards on each ſide thereof, but was far from having the effect I improperly expected; for it evidently appears, the drain could only take a very ſmall portion of the water from ſo large a quick ſand, which it did not penetrate more than two inches; and that it could drain only to its own depth, or, at moſt, to that depth in the fountain which ſupplied the quick ſand. My purpoſe was then defeated; and my motive for mentioning this error, cannot, I hope, be miſtaken.

" I now did what I ought to have done before, that is, examined the different ſtrata to a greater depth, particularly on the bog, and at the upper edges thereof, and found the bog to be what has been deſcribed under the firſt claſs. I therefore determined to attempt the cure in the manner before preſcribed for that claſs, namely, to cut through the whole of the ſtratum, in this inſtance of quick ſand, through which I found the water paſs: this I effected as follows.—The ſummer being dry, and favourable for the purpoſe, and having previouſly made my main open drain, I began my main cloſe drain, the firſt week in June, 1791, three feet wide on the declivity near

"The village itſelf (of which I am ſole proprietor) uſed to be called *Dirty Moreton.* I have now got rid of that appellation, by making through it, at my own expence, as good a road as any in the county of Hereford; and have rendered it not only pleaſing to the eye, but ſafe and commodious to the traveller: it now affords one of the moſt agreeable rides in the vicinity of Hereford."

To this is annexed the following *Summary of Expences.*

	£.	s.	d.
Cutting the new brook, different water-courſes, and open drains	190	0	0
Under or hollow drains, made with ſtone, 7700 yards, at 2d per yard	64	3	4
New road through the eſtate	196	0	0
New bridges	41	18	0
1200 Yards of open draining, part at 3d. and part at 1½d. per yard	12	7	0
23,300 Yards under-draining, made with ſtone, at 2d. per yard	194	3	4
	206	10	4

	£.	s.	d.
Expences in 1790	492	1	4
Expences in 1791	206	10	4
Total Expence	698	11	8

which has improved two hundred and twenty acres, two roods, and thirty-two poles of land, and increaſed its yearly value fifty-ſix pounds, eight ſhillings, and ſix-pence.

"*Explanation of Plate* VI. Fig. 1, No. 1, repreſents the trench, when made, prior to its being filled with ſtone. This trench is generally three feet ſix inches deep, one foot wide at the top, and about four inches wide at the bottom. It is made at three operations, in the following manner: the turf is firſt taken off, about four inches thick, and laid by, to be put on the top of the ſtone: the ſoil is then taken out, about a foot deep, with a ſpade: they next dig another foot, with the inſtrument, No. 3, tapering from the top downwards, and curving a little; and, finally, it is ſunk to its proper depth, with the inſtrument, No. 4, ſimilar to the laſt, but ſmaller in its dimenſions. After it is ſunk to a proper depth, it is cleared and ſmoothed, by drawing the inſtrument, No. 5, along the bottom, which cleans the ſides and the bottom, and brings out the looſe mould which may have accumulated in the working.

"No. 2 repreſents the drain when filled, which is done by placing two of the wideſt and flatteſt of the ſtones, edgeways, on the bottom of the drain, and rearing them againſt the ſides, and afterwards throwing the reſt of the ſtones in promiſcuouſly, generally obſerving to put the largeſt uppermoſt. Upon the ſtones is placed the turf, which was taken from the ſurface: this is inverted, and the graſs ſide put downwards upon the top of the ſtone, to prevent the mould from falling into, and filling up the vacuities. In arable land, ſtraw or ſtubble is made uſe of as a ſubſtitute for the turf. The ſtones in the drains uſually take up about two feet of the depth, and the earth on the top, about eighteen inches.

"In boggy parts, where the bottom is unſound, it is neceſſary to place a ſmall alder pole along the bottom of the drain, to prevent the ſtone ſinking into the ſoil. In wet ſpringy land the water runs through different ſtrata of ſoil, and at different depths in the earth; ſo that a drain, filled two feet high with ſtone, is much more certain to drain land, than a hollow drain made with brick, which is ſeldom more than ten or twelve inches, and is made at a much greater expence.

George Pearſon, Eſq. who received the ſilver medal for improvement by draining, gives the following relation.

"Harperly eſtate is ſituated about fourteen miles to the weſtward of Durham, and five miles from Biſhop Auckland: the greateſt part of the ſoil whereof, is of a loamy quality, with a clay bottom; but the other part, contiguous to the river Wear, is a deep rich ſoil, mixed with gravel.

"About five hundred acres of this eſtate form a hill-ſide, or declivity, which generally falls to the ſouth-weſtward, at the rate of one foot in twenty. The ſtrata near the top of the hill, where a coal-mine has been opened and worked, are as follows, viz. mooriſh earth, mixed with looſe ſtones, ſlate, &c. for about four fathoms; looſe earth and running or quick ſand, two fathoms; free ſtone five fathoms; black ſhale and ſtone, two fathoms; and coal two fathoms.

"This ground declining, or dipping ſouth-weſtward, the whole of the water which ran in the bowels of the different ſtrata above mentioned, at different degrees of the declivity, diſcharged itſelf on the ſurface of various parts of the ground, by which one hundred acres of it were rendered entirely a bog, and whereof about two-thirds would hardly bear an animal, and were of no value; and the other third, of the value of three ſhillings per acre.

"The produce, before draining, was wild marſhy graſs, ruſhes, ſparts, bent, brambles, and bruſhwood. In ſituations like this, there is much more difficulty and expence in draining the ground, than where it lies more upon a level, becauſe the internal ſprings ariſe to the ſurface in ſo many different places, and muſt be taken off and conveyed away in ſo many ſeparate cuts or ſewers.

"In the year 1791, the one hundred acres of land above mentioned were drained by hollow drains of free-ſtone: the drains were cut two feet wide, and from three to five feet deep; and where they were made in a running or quick ſand, the ſole, or bottom, was laid with flag or flat ſtones, to prevent the paſſage from being filled or choaked up by the ſand. Theſe drains contain in the whole, by an actual admeaſurement, ſeven thouſand ſeven hundred and thirty-five yards; and the expence of making them amounted to ſix-pence-halfpenny per yard, upon the average.

"It is ſuppoſed that the drains diſcharge, in dry weather, as much water from each acre, upon an average, as is capable of being paſſed through a tube of two inches diameter; and, in wet weather, when the water has ſunk from the ſurface into the bowels of the different ſtrata, a great deal more. By means of draining the above-mentioned one hundred acres of land, in the manner before deſcribed, the ſame are rendered fit for cultivation, and ſuppoſed to be of the yearly value of fourteen ſhillings an acre, upon the average; and are capable, by proper manuring and huſbandry, of further improvement."

Mr. John Wedge, of Bickenhill, near Coventry, who obtained the ſilver medal for draining land, partly in the Earl of Aylesford's occupation, and partly in his own, communicates to the Society his ideas on the ſubject, as well as an account of his own practice. He ſays, over a ſlow fire; and, when melted, but not boiling, with a hard bruſh, cover the painting with the wax; and, when cold, take a moderately hot iron, ſuch as is uſed for ironing linen, and draw it lightly over the wax. When the picture is nearly cold, rub it with a fine linen cloth, to make it entirely ſmooth; and, when quite cold, rub it again, to make it ſhine.

"Paintings might be executed, in this manner, upon wood, or plaſter of Paris, without requiring any other preparation, than mixing ſome fine plaſter of Paris in powder, with cold water, the thickneſs of a cream; then put it on a looking-glaſs; and, when dry, take it off; and there will be a very ſmooth ſurface for painting upon.

"Paintings may alſo be done in the ſame manner, with only gum water and gum maſtich, prepared the ſame way as the maſtich and wax; but, inſtead of putting ſeven ounces of maſtich, and, when boiling, adding five ounces of wax, mix twelve ounces of gum maſtich with the gum water, before it is put on the fire; and, when ſufficiently boiled and beaten, and is a little cold, ſtir in twelve ounces of cold ſpring water, and afterwards ſtrain it.

"It would be equally practicable painting with wax alone, diſſolved in gum water, in the following manner.

"Weigh twelve ounces of cold ſpring water, and four ounces and a half of gum arabic: put them into a glazed earthen veſſel; and, when the gum is diſſolved, add eight ounces of white wax. Put the earthen veſſel, with the gum water and wax, upon a ſlow fire, and ſtir them, till the wax is diſſolved, and has boiled a few minutes: then take them off the fire, and throw them into a baſon, as, by remaining in the hot earthen veſſel, the wax might become rather hard: beat the gum water and wax till quite cold. As there is but a ſmall proportion of water, in compariſon to the quantity of gum and wax, it would be neceſſary, in mixing this compoſition with the colours, to put alſo ſome fair water.

"It ſhould be obſerved, that the water uſed by Miſs Greenland, in theſe preparations, came from a chalk rock, and remarkably ſoft: poſſibly any other water might anſwer equally well."

MANUFACTURES.

THE *Rev. Mr. Swayne's* paper concerning the culture of ſilk in England, is chiefly employed in calculations of the weight of ſilk produced by a given number of worms, with a view of taking off the force of Mr. Bertezen's aſſertion, that he gained five pounds of ſilk from twelve thouſand worms of his own breed; whereas, according to Miſs Rhodes's calculations, thirty thouſand were neceſſary to produce that quantity. As Mr. Bertezen has left England, and taken his breed and ſecret with him, this notion might operate as a diſcouragement to the raiſing ſilk from our own breeds. Mr. Swayne alſo mentions an unſucceſsful experiment of his own in raiſing mulberry trees from ſeeds; and diſcuſſes, from the opinions of various writers, the queſtion whether the black or white mulberry be preferable for the feeding of ſilkworms. His concluſion is, that each is beſt according as it flouriſhes moſt in its reſpective ſituation; and from his own obſervations he finds, that the white proſper in a moiſter and ſtiffer ſoil than the black.

Mr. Philip James Knights, of Norwich, who obtained the Society's ſilver medal for his manufacture of ſhawls, ſends a letter reſpecting the price at which his goods can be afforded. The counterpane which he ſubmitted for the inſpection of the Society was four yards ſquare, without a ſeam. It would come, retail, to twenty guineas; and is equal in beauty, and far ſuperior in ſtrength, to the Eaſt-India counterpanes of 200 guineas price. Other articles of the ſhawl kind are made by him at a twentieth part of the price of the India ones.

MECHANICS.

MR. BELL, *ſerjeant of the royal regiment of artillery,* received a premium of fifty guineas for his invention to preſerve the lives of perſons on board ſhips ſtranded near the ſhore. On application to the maſter general of the ordnance, proper trials were made, by throwing a loaded ſhell* on ſhore, from a ſmall mortar, fixed in a boat, moored in the river, about two hundred yards from the ſhore. To the ſhell was attached a rope, one end of which remained on board the boat; and the ſhell falling about one hundred yards within land, buried itſelf about eighteen inches in the gravel; when Mr. Bell and another perſon, on a raft, floated by caſks, properly ballaſted, hauled themſelves on ſhore, in a few minutes, by the before-mentioned rope. Theſe trials having been three times repeated with the deſired ſucceſs; and it appearing that the method propoſed by Mr. Bell, of throwing a line on ſhore, from a ſhip in diſtreſs, either ſtranded, or in danger of being ſo, promiſes to be of infinite advantage in the maritime world, as by means thereof ſuch veſſel may obtain relief; any perſon, when landed, being enabled to ſecure ropes from the ſhip, or additional hands may be conveyed thereby from the ſhore, to aſſiſt thoſe on board; and, in caſes of imminent danger, where all hopes of ſaving the ſhip may be loſt, Mr. Bell's method offers the moſt probable means of ſaving the lives of the crew.

Capt. Edward Packenham preſented to the Society an account of a method for reſtoring maſts of ſhips when wounded, in an eaſy, cheap, and expeditious manner. His plan is to have the heels of all lower maſts ſo formed, as to become the heads: but it is not the intention of the above plan to have the ſmalleſt alteration made in the heels of the preſent lower maſts; for, as all line-of-battle ſhips maſts are nine inches in diameter larger at the heal than at the head, it will follow, that, by letting in the treſſel-trees to their proper depth, the maſt will form its own cheeks or hounds. He ſays,

"I muſt beg to obſerve, that all line-of-battle ſhips bury one third of their lower maſts, particularly three-deckers: it therefore follows, that, if the wounds are in the upper third, by turning the maſt, ſo as to make the heel the head, it will be as good as new. This ſubſtitute is formed on the moſt ſimple principle, fitted to the meaneſt capacity,

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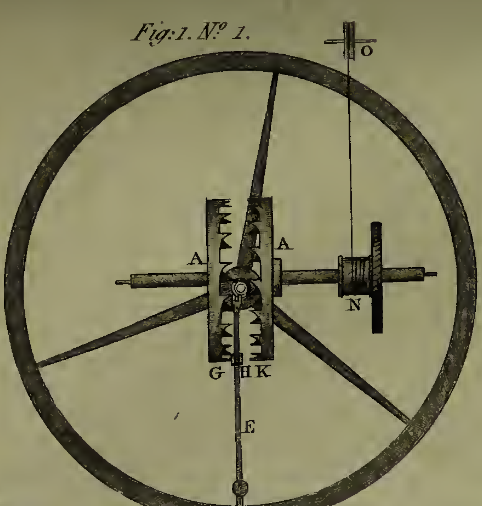
* By a loaded ſhell, is meant a ſhell filled with lead, by which means a ſtaple, or ring, may be fixed, to which the rope is to be made faſt: the ſhell, thus loaded, weighed about ſeventy pounds, and was eight inches in diameter.

Fig: 1. No. 1.



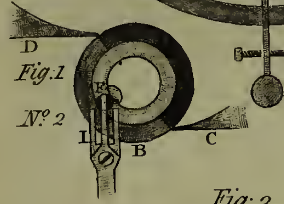


Fig: 1
No. 2

Fig: 2.

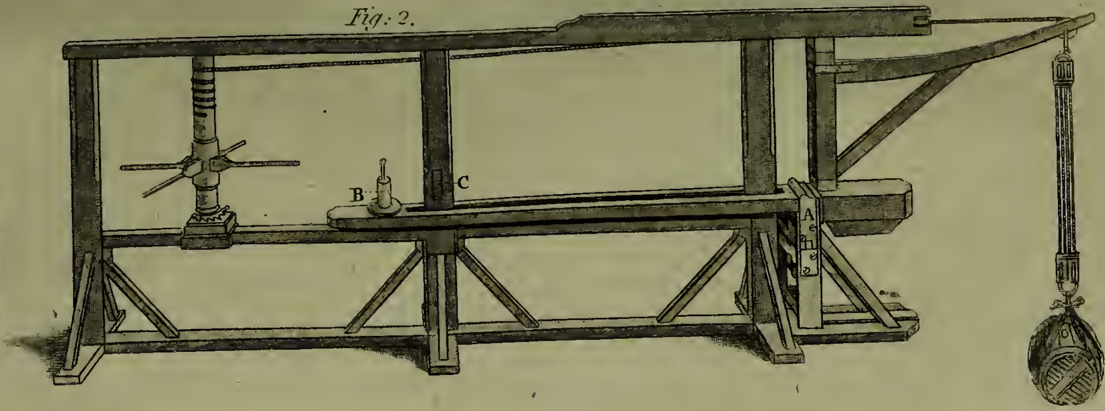


Fig: 3. No. 2.

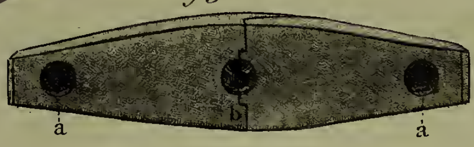


Fig: 3. No. 3.

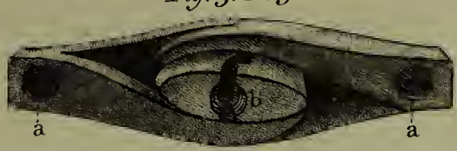


Fig: 4. No. 4.

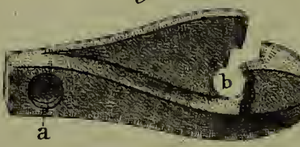


Fig: 3. No. 1.

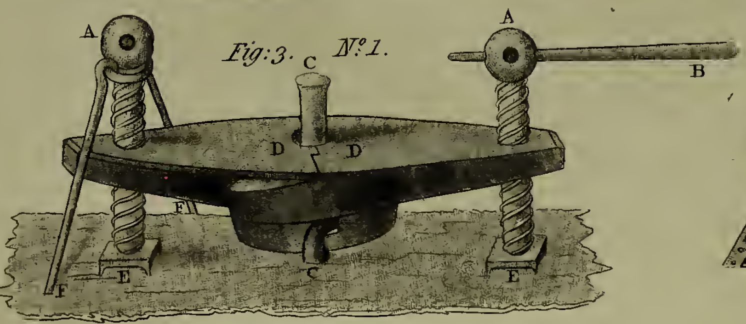
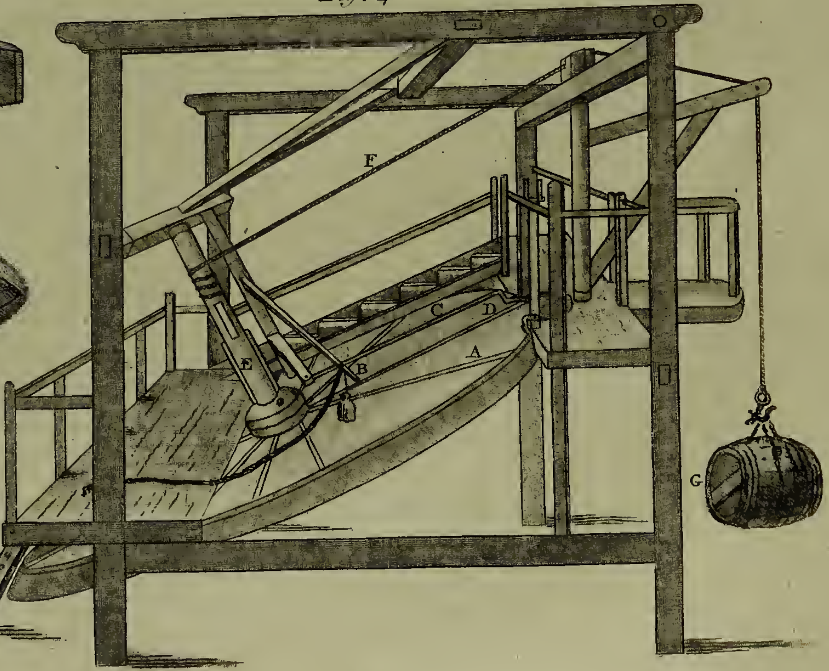


Fig: 4.



capacity, and calculated to benefit all ſhips, from a firſt-rate down to the ſmalleſt merchantman, in caſes of an accident by ſhot, a ſpring, a rottenneſs, particularly as thoſe accidents generally happen in the upper third of the maſt, and about the cheeks. The wounded part being by this means brought below the wedges, may eaſily be fiſhed, caſed and ſecured."

Mr. William Howells received thirty pounds for an improved eſcapement for watches and clocks. See Plate V. Fig. 1.

No. 1. AA. Two crown wheels fixed upon the ſame axis, paſſing near to the ſtaff of the verge, ſupported by two counter pottances upon the upper plate.

F. The balance, ſupported by cock and pottance.

E. The detent, that locks the wheels, alternately ſupported by a cock upon the upper plate, with two ſcrews to bank.

N. A barrel, with click and ratclut, and ſmall thread round it, paſſing over the pulley O, by which a weight is hung, to ſet it a going, as ſhewn in the model.

No. 2. B. A ſemi-circular pallet, which the tooth C is juſt quitting, and the tooth D is going to take: the wheels are locked by the pallet H, upon the detent E (No. 1), till the pin F (No. 2), upon the verge, takes it into the fork, and relieves the tooth G (No. 1) from the pallet, and carries it to I (No. 2); and the pin F will have carried the detent E, with the pallet H, and locked the tooth of the wheel at K.

Mr. Abraham Andrews received fifteen guineas for his invention of a crane, whereby the body ſuſpended is weighed during the time of raiſing. See Plate V. Fig. 2.

The gib of the crane ſtands on a horizontal beam, moveable on a centre, at A: and the diſtance of the centre A, from the bearing of the upright, being, to the diſtance at B, as one to twenty; the weight placed at B, determines the weight of the body ſuſpended, in the proportion as one is to twenty. C is a ſtub or projection of wood, ſerving to prevent the beam riſing too high, from the weight hanging at the end of the gib.

Mr. William Hill, of Butt Lane, Deptford, received forty guineas for the following invention for drawing bolts out of ſhips. See Plate V. Fig. 3.

AA. (No. 1) two ſtrong male ſcrews, working in female ſcrews near the extremities of the cheeks, againſt plates of iron, EE.

CC. The bolt to be drawn, which, being held between the chaps of the machine, at DD, is, by turning the ſcrews by the lever B, forced upwards out of the wood or plank of the ſhip. FF are two dogs, with hooks at their lower extremities, which, being driven into the plank, ſerve to ſupport the machine till the chaps have got faſt hold of the bolt. At the upper part of theſe dogs, are rings paſſing through holes in a collar, moveable near the heads of the ſcrews.

No. 2. is a view of the upper ſide of the cheeks, when joined together; *a a*, the holes in which the ſcrews work; *b*, the chaps by which the bolts are drawn.

No. 3. The under ſide of the cheek; *a a*, the holes in which the ſcrews work; *b*, the chaps by which the bolts are drawn, and where the teeth that gripe the bolt are more diſtinctly ſhewn.

No. 4. One of the cheeks ſeparated from the other, the letters referring, as in No. 2 and 3.

Some experiments have been made of the machine and ſucceeded.

Mr. James White received a premium of forty guineas for a model of a crane for wharfs. See Plate V. Fig. 4.

A. A circular-inclined plane, moving on a pivot underneath it, and carrying round with it, the axis E.

A perſon walking on this plane, and preſſing againſt the lever B, throws off the gripe D by means of an iron rod C, and thus admits the plane and its axis to move freely, and raiſe the weight G, by the coiling of the rope F round the axis E.

To ſhew more clearly the conſtruction and action of the lever and gripe, a plan of the circular-inclined plane, with the lever and gripe, is added, where B repreſents the lever, D the ſpring or gripe. In this plan, when the lever B is in the ſituation it now appears, the ſpring or gripe D preſſes againſt the periphery of the plane, as ſhewn by the double line; and the machine cannot move, but when the lever B is preſſed out to the dotted line H: the gripe is alſo thrown off to the dotted line I, and the whole machine left at liberty to move. One end of a rope or cord, of a proper length, is fixed near the end of the lever B, and the other end made faſt to one of the uprights, ſerving to prevent the lever moving too far, when preſſed by the man.

COLONIES AND TRADE.

GEORGE UNWIN, Eſq. obtained the gold medal for having been inſtrumental in reviving the tin trade to India and China; of the ſucceſs of which attempt he gives a ſhort account. In the year 1789, between 7 and 800 tons were ſent from Cornwall to China, where it met with a ready ſale, and produced a balance of about 35 per cent. to pay all charges, with a requiſition that the quantity might be increaſed to 1200 tons. In conſequence of theſe exports, the price of tin for the European markets has riſen from 58s. to 72s. per cwt. in Cornwall; by which that county is now enjoying a receipt of between 30 and 40,000l. per annum, the greateſt part of which is received from foreigners; and the tin-trade there is ſo flouriſhing, that every man, woman, and child, who can work in tin-works, may find conſtant employment.

Two ſhort letters from *Dr. Dancer, of Jamaica*, relative to the culture of cinnamon and other products in that iſland, are next printed, with the following notice prefixed. "The ſamples of cinnamon mentioned in the doctor's letter, dated July 12, 1791, having been examined by a committee, at which were preſent ſome of the moſt eminent dealers in that ſpice, it was unanimouſly their opinion, that the cinnamons No. 2 and 3 are excellent in their kinds, and preferable to any cinnamon imported from Ceylon, both in colour and flavour, and that all the ſamples are of a fine flavour."

Philoſophical

Philoſophical Tranſactions of the Royal Society of London, for the Year 1792. *Part* I.

I. *On the Ring of Saturn, and the Rotation of the Fifth Satellite upon its Axis.*

By WILLIAM HERSCHEL, *L.L.D. F.R.S.*

IT is well known to aſtronomers that the ring of Saturn becomes alternately enlightened on one of its ſides, and that this change of illumination takes place when the planet paſſes through the node of the ring. This happened in October, 1789, when the ſouthern plane, which had been in the dark for about fifteen years, became viſible to us: an event to which I have looked forwards with conſiderable impatience. In the year 1790, the poſition of the ring was ſtill too oblique to permit me to examine it well enough to form a proper judgment of its appearance, but lately I have been able to view it to greater advantage, with every one of my teleſcopes.

In a former paper, where I ventured to hint at a diviſion of the ring of Saturn, it was highly neceſſary to expreſs that ſurmiſe with proper doubts concerning the reality of ſo wonderful a conſtruction: but my late views of its ſouthern plane, aſſiſted by ſome concluſions drawn from the diſcovery of the quick rotation of the ring, have enabled me to ſpeak deciſively on this ſubject. My ſuſpicion of a divided or double ring aroſe chiefly from the following circumſtances.

In the firſt place, the black belt, during the time of about ten years that I obſerved it, on the northern plane, was ſubject to no kind of change; but remained always, permanently, of the ſame breadth and colour. With regard to its breadth, it is true that I could only judge of that part of it which goes acroſs the body of the planet, by the rules of perſpective, which made me ſuppoſe it to be as broad there as it was on the two ſides; yet now, as we know that the ring revolves in about ten hours and a half, it is very certain, that the apparently narrow part, acroſs the body, and that which was hidden behind the planet, in the courſe of an evening, when I have been obſerving Saturn for many hours together, muſt have been expoſed to view in their full breadth, upon the ſides of the ring; and that, if there had been any difference, I muſt have perceived it; eſpecially as I was continually on the look out for ſuch phænomena, by way of aſcertaining, if poſſible, the rotation of the ring.*

In the next place, the colour of this dark belt was alſo uniformly the ſame, whenever I obſerved it under equally favourable circumſtances; and being ſo well defined on both its borders, and, in every part of the revolving ring, preſenting us with the ſame view of colour, breadth, and ſharpneſs of its outlines, no kind of hypotheſis but a diviſion of the ring, through which the open heavens may be ſeen, will anſwer the conditions of this phænomenon. It remained therefore only to aſcertain, whether the ſouthern plane would preſent us with the ſame aſpect.

From a variety of obſervations with a 7 feet, 10 feet, 20 feet, as well as the 40 feet reflector, from 7th Sept. 1790, to 24th October, 1791, together with what has been given in ſome former papers, I think myſelf authoriſed now to ſay, that the planet Saturn has two concentric rings, of unequal dimenſions and breadth, ſituated in one plane, which is probably not much inclined to the equator of the planet. Theſe rings are at a conſiderable diſtance from each other, the ſmalleſt being much leſs in diameter at the outſide, than the largeſt is at the inſide.

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* When I ſay that the black diviſion was always of the ſame breadth, I do not mean to exclude very ſmall variations, not only of the breadth of the black mark, but of the ring itſelf, which I have occaſionally obſerved, and which it may be neceſſary, hereafter, to communicate at full length; but theſe almoſt imperceptible, differences might ariſe from cauſes that are foreign to our preſent purpoſe.

The dimenſion of the two rings and the intermediate ſpace are nearly in the following proportion to each other.

Inſide diameter of the ſmalleſt ring - - -	5900 parts
Outſide diameter - - - - - -	7510
Inſide diameter of the largeſt ring - - - -	7740
Outſide diameter - - - - - - -	8300
Breadth of the inner ring - - - - -	805
Breadth of the outer ring - - - - -	280
Breadth of the vacant ſpace - - - - -	115

Admitting, with M. de la Lande, that the breadth of the whole ring, as formerly ſuppoſed to conſiſt of one entire maſs, is near one third of the diameter of Saturn, it follows that the vacant ſpace between the two rings, according to the above ſtatement, amounts to near 2513 miles.

As I have given the revolution of the ring, which was then ſuppoſed to be all in one united maſs, it will be neceſſary to examine, whether both rings partake in the ſame revolution, or to which the period which has been aſſigned belongs?

In the year 1796, the plane of the ring will be fully expoſed to our view, and will therefore afford an opportunity of examining it more minutely in reſpect to a ſecond black liſt which I ſaw in the year 1780.

It does not appear to me that there is a ſufficient ground for admitting the ring of Saturn to be of a very changeable nature, and I gueſs that its phænomena will hereafter be ſo fully explained, as to reconcile all obſervations. In the mean while, we muſt with-hold a final judgment of its conſtruction, till we can have more obſervations. Its diviſion, however, into two very unequal parts, can admit of no doubt; and the following are meaſures taken of the diameter of the largeſt or outward ring.

1791. October 7. With 20 feet reflector, greateſt of 7. 54″,679 leaſt 52″,537 mean of the whole 53,″366 when this is reduced to what it would be when Saturn is at its mean.

1791.	Diſtance from the earth we have — — —	46″ ,832
	October 24. With 40 feet reflector — — — —	47 ,241
	November 21. With ditto — — — — —	45 ,803
	Mean	46 ,625

By way of forming more eaſily a comparative idea of the ſtupendous ſize of this ring of Saturn, I have calculated the proportion it bears to the earth, and find that its diameter is to that of the latter as 25,8914 to 1; and that conſequently, when ſeen at the mean diſtance of the ſun, it will ſubtend an angle of 7′, 25″,332.

From the above proportions we alſo compute that this ring muſt be upwards of 204883 miles in diameter.* See repreſentation of Saturn and his ring. Plate VI. Fig. 2.

On

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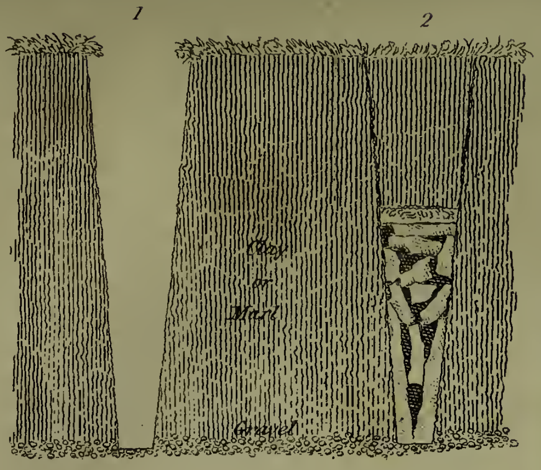
* In this calculation I have uſed for the earth's diameter the ſum of the longer and ſhorter ſemi-axes which are given in Mr. Dalby's Paper, publiſhed in the laſt volume of the Philoſophical Tranſactions. If we compute the vacant ſpace between the two rings immediately from the above dimenſions of the outward ring, we ſhall have 2839 miles; and this will certainly be more accurate than the reſult which has been drawn from the proportion of the breadth of the ring to the diameter of Saturn.

Fig 1



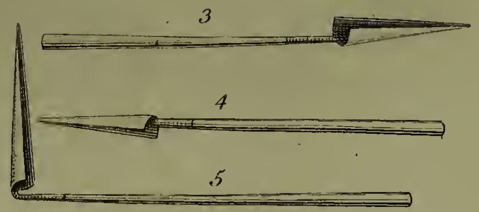


Fig 3

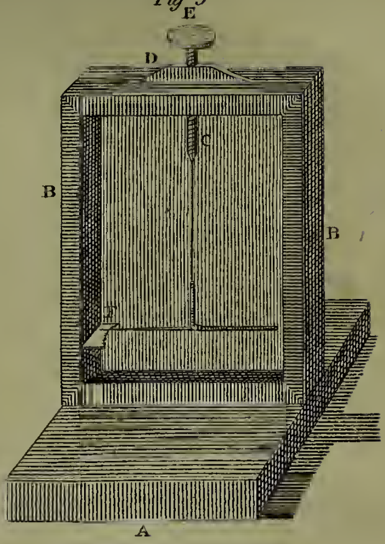


Fig 2

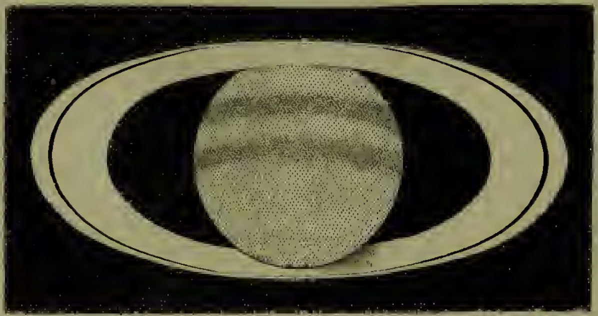
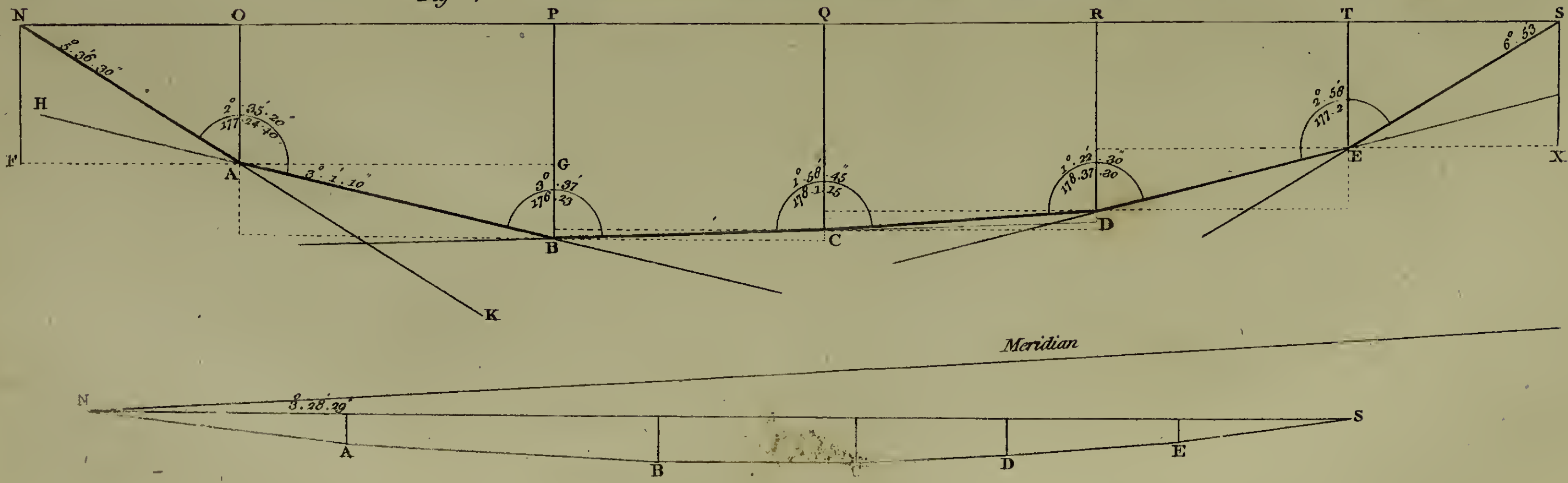


Fig 4



On the Rotation of the fifth Satellite of Saturn, on its Axis.

In my frequent obſervations of the Saturnian ſyſtem, I remarked, that the 5th ſatellite is ſubject to a change of brightneſs. This having been noticed before by other obſervers, I did not at firſt pay ſo much attention to it as I ſoon afterwards found this circumſtance deſerved. When I ſaw this ſatellite always aſſume the ſame brightneſs in the ſame part of its orbit, and perceived that its change was regular and periodical, it occurred to me very naturally, that the cauſe of this phænomenon could be no other than a rotation upon its axis. It became neceſſary therefore to find out a method to determine the time of this rotation.

In order to inveſtigate this, I purſued the ſatellite with great attention, and marked all its changes of apparent brightneſs. The reſult of many obſervations is as follows. The light of the ſatellite is in full ſplendour during the time it runs through that part of its orbit which is between 68 and 129 degrees paſt the inferior conjunction. In paſſing through this arch it does not fall above one magnitude ſhort of the brightneſs of the 4th ſatellite. On the contrary, from about 7 degrees paſt the oppoſition till towards the inferior conjunction, it is not only leſs bright than the 3d, but hardly, if at all, exceeds the 2d, or even the 1ſt ſatellite; provided the latter be then about its greateſt elongation, where its light is leaſt impeded by the brightneſs of the planet. Upon the whole, the alteration ſeems to amount to what among the fixed ſtars, and with the naked eye, would be called a change from the 5th to the ſecond, and from the 2d to the 5th magnitude.

Having thus obſerved this ſatellite, for many of its revolutions round the primary planet, to loſe and regain its light regularly, it is evident that the time of its rotation on its axis cannot differ much from that of its revolution 'round Saturn. I think myſelf ſufficiently authorized to make this concluſion, notwithſtanding it may have happened ſometimes that the light of the ſatellite has ſuffered an occaſional change, of ſhort duration, from other cauſes; for the ſame reaſon that we ſhould certainly allow thoſe who firſt ſaw the ſpots in the ſun to be in the right to aſſign the period of its rotation nearly, when they perceived that the ſame ſpot made ſeveral revolutions, notwithſtanding that ſpot might afterwards vaniſh. But I may go farther, and aſcertain upon ſufficient grounds, that this ſatellite turns once upon its axis, exactly in the time it performs one revolution round its primary planet. This degree of accuracy is obtained by taking in the obſervations of M. Caſſini, which are related in the *Mémoires de l'Académie des Sciences*, 1705, page 121; where we find it mentioned, that "the 5th "ſatellite of Saturn diſappears regularly for about one half of its revolution, when it "is to the eaſt of Saturn." The ſame memoir contains alſo a conjecture of this ſatellite's rotation upon its axis; but this ſurmiſe is contradicted as premature, in 1707, page 96; where we find the following paragraph. "M. Caſſini gives an example of "the danger there is in theſe ſort of determinations, that are made too haſtily. The "5th ſatellite of Saturn, of which we have ſaid, in the hiſtory of 1705, page 121, that it "grew inviſible, in the eaſtern half of the circle it deſcribes about Saturn, began, in the "month of September 1705, to be there viſible, as well as in the weſtern half, "where it always was ſo. Hence the conjectures which we have related ceaſe to be "well founded."

Now, without determining whether the ſatellite, from ſome cauſe or other, ceaſed to change its brightneſs, or whether its phænomena were not ſufficiently followed to come to a proper concluſion, I think that with the aſſiſtance of obſervations at ſo great a diſtance of time as thoſe of M. Caſſini, I may ſufficiently eſtabliſh the period of this ſatellite's rotation. For ſince I have traced the regular, and periodical change of light, through more than ten revolutions, and find them, in all appearance, to be contemporary with its return about Saturn, it leads us directly to a ſtrong preſumption that its rotation upon its axis, like that of our moon, ſtrictly coincides with its revolution round its primary planet; and the obſervations of M. Caſſini completely confirm this concluſion.

Now, by joining thoſe to mine, we have a ſhort period of near 20 revolutions that agree together, ſo as to preclude all doubt of any intermediate change; and therefore we cannot be liable to err, when we extend this period to all the 397 revolutions ſince Caſſini's time, and by that means aſcertain that the 5th ſatellite of Saturn turns upon its axis, once in 79 days, 7 hours, and 47 minutes.

I cannot help reflecting, with ſome pleaſure, on the diſcovery of an analogy, which ſhews that a certain, uniform plan is carried on among the ſecondaries of our ſolar ſyſtem; and we may conjecture, that probably moſt of the moons of all the planets are governed by the ſame law.

On the Diſtance of the fifth Satellite.

The diſtance of the 5th ſatellite from Saturn is allowed to be the moſt proper for obtaining a true meaſure of the quantity of matter contained in the planet; for which reaſon I have taken many meaſures of it with the 20-feet reflector. I give them at full length, that the validity of them may appear in its proper light.

1791. September 25. Diſtance of 5th Satellite of Saturn from the center of the planet; meaſured with the 20 feet reflector, and a magnifying power 157.

					Correction of clock for midnight.
September	25th.	Mean of 6th	at 23h. 37′	8 55″,5	2′ 19″,5
	26th.	Mean of 6	at 23 33	9 5 ,8	2 19 ,8
	27th.	Mean of 6	at 23 4	9 20 ,5	2 20 ,8
	28th.	Mean of 6	at 21 48	9 28 ,4	2 20 ,2
	30th.	Mean of 6	at 0 27	9 36 ,9	2 20 ,4
					☞ the day of month is a correction
	30th.	Mean of 6	at 20 35	9 38 ,5	2 20 ,6
October	1ſt.	Mean of 6	at 1 16	9 40 ,4	2 20 ,0
	1ſt.	Mean of 6	at 22 31	9 43 ,0	

It grew cloudy, ſo that no meaſures later in the night could be obtained; nor could I get another ſight of Saturn till October the 7th, when the ſatellite was far advanced in its orbit, on its return towards the planet.

Suppoſing the ſatellite to have been very nearly at its greateſt elongation, when the laſt ſix meaſures were taken, I have reduced them to the mean diſtance of Saturn, where they give 8′ 31″,97.

I forbear making deductions from this reſult, with reſpect to the quantity of matter contained in the planet, as, poſſibly, the orbit of the ſatellite may be conſiderably elliptical; in which caſe meaſures taken in oppoſite parts of that orbit will be required, before we can make a ſtrict application of the laws of centripetal forces.

II. *Miſcellaneous*

II. *Miſcellaneous Obſervations, &c.* *By* WILLIAM HERSCHEL.

Account of a Comet.

THURSDAY December 15, with a 7 feet reflector, I ſaw a pretty large teleſcopic comet, at *9h* 42′ 4″,8 true mean time, it followed the ſecond of Flamſteed's ſtars in the conſtellation of Lacerta 1′ 40″,2 of time, and was 48′ 21″,8 ſouth of the ſame. The apparent motion was direct, and at about three minutes of time in Æ and a little more than 2° of polar diſtance per day. On the 16th, beſides the ſcattered, and gradually dimiſhing light, which reached nearly to a diſtance of three minutes every way beyond the bright centre, there was alſo a faintly extended, ill defined, pretty broad ray, of about 15 minutes in length, directed towards the north following part of the heaven, which might be called the tail of the comet.

Its place for the ſame night (December 16th) was determined by a five-feet Newtonian Sweeper, carrying an equilateral triangle in the focus of the eye-glaſs, not ſo large but that the three interſections, made by the wires at the three angles, may be diſtinctly perceived. At *5h* 49′ 40″,6 it preceded the 6th Lacerta 4′ 58″,5 in time, and was 52′ 14″,5 more north than that ſtar.

On the Periodical Appearance of o Ceti.

The changeable ſtar in the neck of the Whale, *o* Ceti, continues its variations as uſual, but with ſome conſiderable irregularities of brightneſs.

In the year 1779, as we have ſeen, it excelled α Arietis ſo far as almoſt to rival Aldebaran; and continued in that ſtate a full month.

In 1780, its greateſt brightneſs was only like that of δ Ceti.

In the year 1781, it did not come up to the brightneſs of δ

In 1782, this ſtar increaſed to the ſize of β Ceti, and continued bright for more than twenty days.

In 1783, it did not only vaniſh to the naked eye, as uſual, but diſappeared ſo completely, that I could not find it with a teleſcope, which permitted not a ſtar of the 10th magnitude to eſcape me. When it increaſed again, it did not amount to the brightneſs of δ.

In 1784, I ſaw it only of the 8th magnitude in a twenty-feet reflector, but as I did not continue to obſerve it regularly, it might poſſibly change as uſual.

In 1789, it arrived to the brightneſs of α Piſcium, or rather excelled it.

In 1790, the greateſt brightneſs was almoſt equal to that of α Ceti.

From theſe and the obſervation of Fabricius on 13th of Auguſt 1596, when the ſtar was in its greateſt luſtre, it may be admitted to have undergone 214 changes, by which long interval we obtain the period of 331 days, 10*h*. 19*m*. which differs not from M. Bouilland's determination only one day and a half.

On the Diſappearance of the 55th Herculis.

Among the changes that happen in the ſidereal heavens we enumerate the loſs of ſtars; but, notwithſtanding the real deſtruction of an heavenly body may not be impoſſible, we have ſome reaſon to think that the diſappearance of a ſtar is probably owing to cauſes which are of the ſame nature with thoſe that act upon periodical ſtars, when they occaſion their temporary occultations. This ſubject, however, being of great extent and conſequence, we ſhall not enter into it at preſent, but only relate a recent inſtance of the kind.

Two ſtars of the 5th magnitude, whoſe places we find inſerted in all our beſt catalogues, were to be ſeen in the neck of Hercules. They are the 54th and 55th of Flamſteed's, in that conſtellation. In the year 1781, the 10th of October, I examined them both, and marked down their colour, red. The 11th of April, 1782, I looked at them again, and noted my having ſeen them diſtinctly, with a power of 460; and that they were ſingle ſtars.

The 24th of laſt May, I miſſed one of the two, and examining the ſpot again the 25th, and many times afterwards, found that one of them was not to be ſeen. The ſituation of the ſtars is ſuch that, not having fixed inſtruments, I could not well determine which of the two was the loſt one. I therefore requeſted the favour of my much eſteemed friend, the aſtronomer royal, to aſcertain the remaining ſtar; and it appears from Dr. Maſkelyne's anſwer to my letter, that the 55th Herculis is the one which we have loſt.

Remarkable Phænomena in an Eclipſe of the Moon.

The 22d of October, 1790, when the moon was totally eclipſed, I viewed the diſk of it with a twenty-feet reflector, carrying a magnifying power of 360. In ſeveral parts of it I perceived many bright, red, luminous points. Moſt of them were ſmall and round. The brightneſs of the moon, notwithſtanding the great defalcation of light occaſioned by the eclipſe, would not permit me to view it long enough to take the places of theſe points. They were, indeed, very numerous; as I ſuppoſe that I ſaw, at leaſt, one hundred and fifty of them. Their light did not much exceed that of Mons Porphyrites Hevelii.

We know too little of the ſurface of the moon to venture at a ſurmiſe of the cauſe from whence the great brightneſs, ſimilarity, and remarkable colour of theſe points could ariſe.

III. *Experiments and Obſervations on the Production of Light from different Bodies, by Heat, and by Attraction.* *By Mr.* Thomas Wedgwood.

AFTER giving a ſhort hiſtory of the diſcoveries which relate to the phoſphoriſm of different bodies, Mr. Wedgwood proceeds to the detail of his own experiments, which he divides into two claſſes. 1ſt. Comprehending thoſe bodies which emit light in conſequence of the application of heat. 2. Thoſe which give out light upon attrition.

I. The method of heating the bodies, was by reducing them to powder, and ſprinkling ſome of their powder on a thick heated plate of iron, or maſs of burnt luting made of ſand and clay, heated juſt below viſible redneſs.

The following is a liſt of the bodies which Mr. Wedgwood found to be luminous, by this treatment.

1. Blue fluor, from Derbyſhire, giving out a fetid ſmell on attrition. 2. Black and grey marbles, and fetid white marbles, from Derbyſhire. Common blue fluor, from Derbyſhire. Red feldſpat, from Saxony. 3. Diamond. Oriental ruby. Aerated barytes, from Chorley, in Lancaſhire. Common whiting. Iceland ſpar. Sea ſhells.

Moorſtone, from Cornwall. White fluor, from Derbyſhire. 4. Pure calcareous earth, precipitated from an acid ſolution. Pure argillaceous earth (of alum). Pure ſiliceous earth. Pure new earth, from Sydney Cove. Common magneſia. Vitriolated barytes, from Scotland. Steatites, from Cornwall. Alabaſter. Porcelain clay of Cornwall. Mother of pearl. Black flint. Hard white marble. Rock cryſtal, from the Eaſt Indies. White quartz. Porcelain. Common earthen ware. Whinſtone. Emery. Coal aſhes. Sea ſand. 5. Gold, platina, ſilver, copper, iron, lead, tin, biſmuth, cobalt, zink. Precipitates by an alkali from acid ſolutions of gold, ſilver, copper, iron, zink, biſmuth, tin, lead, cobalt, mercury, antimony, manganeſe. Vitriolated tartar, cryſtals of tartar, borax, alum; previouſly exſiccated. Sea coal. White paper, white linen, white woollen; in ſmall pieces. White hair powder. Deal ſawduſt. Rotten wood (not otherwiſe luminous). White aſbeſtos. Red irony mica. Deep red porcelain. 6. Antimony, nickel. Oils, lamp, linſeed, and olive, white wax, ſpermaceti, butter; luminous at and below boiling.

Bodies emit their light when immerſed in boiling oil of vitriol, or boiling oils. " powdered marble, and probably every other body when ſpread on the heater in the receiver of the air pump," is equally luminous during the exhauſtion and readmiſſion of the air. " Bodies are by far moſt luminous the firſt time they are heated."

The ſofter the body the leſs heat is in general required.

II. The experiments on the light produced from different bodies by attrition, were chiefly made by rubbing in the dark, two pieces of the ſame kind againſt each other.

In the following liſt they are arranged according to the apparent intenſity of their light, and as the lights are either white, or ſome ſhade of red figures have been offered to denote theſe differences; (0) denoting a pure white; (1), the fainteſt tinge of red, or flame colour; (2), a deeper ſhade of red; (3) and (4), ſtill deeper ones.

1. Colourleſs, tranſparent, oriental rock cryſtal; and ſiliceous cryſtals (0). 2. Diamond (0). 3. White quartz; white ſemitranſparent agate (1). 4. White agate, more opake (2). Semitranſparent feldſpat, from Scotland (2). Brown opake feldſpat, from Saxony (4). Chert of a duſky white, from North Wales (3). 5. Oriental ruby (4). 6. Topaz; oriental ſapphire (0). 7. Agate, deep coloured, brown and opake (4). 8. Clear, blackiſh gun-flint (2). 9. Tawney ſemitranſparent flint (3). 10. Unglazed white biſcuit earthen ware (4). 11. Fine white porcelain (2). 12. Clear, blackiſh gun-flint, made opake by heat (3). 13. Flint glaſs (0). 14. Plate glaſs; green bottle glaſs (0). 15. Fine hard loaf ſugar (0). 16. Moorſtone, from Cornwall (1). Corune, ſemitranſparent, from the Eaſt Indies (1). 17. Iceland ſpar (0). 18. White enamel (2); tobacco pipe (3). White Mica (0). 19. Unglazed biſcuit earthen ware, blackened by expoſing it, buried in charcoal in a cloſe crucible, to a white heat (4). 20. *Black vitreous maſs, made by melting together 5 of fluor, 1 of lime, and ſome charcoal powder (4). 21. Fluor; aerated and vitriolated barytes; white and black Derbyſhire marble; calcareous ſpar; cryſtals of borax; deep blue glaſs; mother of pearl.

Mr. Wedgwood next enters upon a ſeries of argument to prove that bodies which emit light by attrition, do ſo only in conſequence of being heated.

IV. *Ex-*

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* Some of this mixture taken out of the crucible before it was perfectly fuſed, gave out, when rubbed, a ſtrong ſmell like phoſphorus of urine; and on throwing ſome of it pulverized on a plate of iron, heated juſt below redneſs, it was very luminous, and preſented every appearance of burning phoſphorus.

IV. *Experiments upon Heat. By Major General Sir* BENJAMIN THOMPSON, *Knt. F. R. S.*

IT is of importance to aſcertain by experiment the laws of the communication of heat from one body to another, ſo that in many of the uſeful purpoſes of life meaſures may be taken for properly confining and directing its operations.

The firſt ſtep to be taken in ſuch an enquiry is to determine the cauſe of the conducting or nonconducting power of bodies. To this end Sir B. Thompſon inſtituted a number of experiments relative to the conducting powers of various bodies, both ſolids and fluids, an account of which he gave in the Philoſophical Tranſactions for 1786. The preſent paper is a continuation of the ſubject.

The method of making the experiments was as follows: a mercurial thermometer,* whoſe bulb was about $\frac{55}{100}$ of an inch in diameter, and its tube, about 10 inches in length, was ſuſpended in the axis of a cylindrical glaſs tube, about $\frac{3}{4}$ of an inch in diameter, ending with a globe $1\frac{6}{10}$ inch in diameter, in ſuch a manner that the centre of the bulb of the thermometer occupied the centre of the globe; and the ſpace between the internal furface of the globe and the ſurface of the bulb of the thermometer being filled with the ſubſtance whoſe conducting power was to be determined, the inſtrument was heated in boiling water, and afterwards being plunged into a freezing mixture of pounded ice and water, the times of cooling were obſerved, and noted down.

The tube of the thermometer was divided at every tenth degree from 0°, or the point of freezing, to 80°, that of boiling water, and theſe diviſions being marked upon the tube with a point of a diamond, and the cylindrical tube being left empty, the height of the mercury in the tube of the thermometer was ſeen through it.

The thermometer was confined in its place by means of a ſtopple of cork, about $1\frac{1}{2}$ inch long, fitted to the mouth of the cylindrical tube, through the centre of which the end of the tube of the thermometer paſſed, and in which it was cemented.

To all inſtruments of this kind, Sir Benjamin gives the name of *paſſage thermometer.*

This inſtrument was heated to a degree or two above 75°, then held over the veſſel containing the pounded ice, and the moment the mercury deſcended to 75°, it was plunged into the ice and water. The time of the paſſage of the mercury over the diviſions of the thermometer marking 70°, and every tenth degree to 10°, was noted by a watch which beat half ſeconds; and during the time of cooling, the inſtrument was conſtantly moved about in this mixture.

The firſt attempt was to aſcertain the relative conducting powers of ſome of the ſubſtances employed in cloathing, viz. *raw ſilk*, *ſheeps wool*, *linen* ſcraped in the form of the fineſt lint, the *fur of the beaver*, the fineſt part of the *fur of a white Ruſſian bear*, and *Eider down*. Of each of theſe, 16 grains was ſucceſſively introduced into the globe of the paſſage thermometer. But as the interſtices of theſe bodies was filled with air, it was neceſſary firſt to make the experiment with air alone. Now the conducting powers of the different bodies, being inverſely as the time elapſed during the paſſage of the mercury, it appeared that of the ſubſtances already mentioned hares fur, and Eider down were the warmeſt; after theſe beavers fur; raw ſilk; ſheeps wool; cotton wool; and laſtly lint. Being ſurpriſed at the little difference in the warmth of theſe ſubſtances, and ſuſpecting it to ariſe from the volumes or ſolid contents of the ſubſtances being different (though their weights were the ſame), owing to the difference of their ſpecific gravity, Sir Benjamin was led to inſtitute a great number of other and very judicious experiments, from which he was led to the following concluſions. 1ſt. That air is a very bad conductor of heat, and does not communicate it as other bodies generally do, that is, from one particle to another whilſt they remained in their places, but only by a ſucceſſion of contact.

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* See Phil. Tranſ. Vol. LXXVI. Tab. VI. Fig. 4.

2dly. That the greater or leſſer heat of many bodies depends on the air included in the interſtices.

3dly. That the air thus encloſed, is prevented from a quick change of place by the attraction which certain bodies have for the air.

In furs, for inſtance, the attraction between the particles of air, and the fine hairs in which it is concealed, being greater than the increaſed elaſticity, or repulſion of thoſe particles with regard to each other, ariſing from the heat communicated to them by the animal body, the air in the fur, though heated, is not eaſily diſplaced; and this coat of confined air is the real barrier which defends the animal body from the external cold. This air cannot carry off the heat of the animal, becauſe it is itſelf confined, by its attraction to the hair or fur; and it tranſmits it with great difficulty, if it tranſmits it all.

Hence the fineſt, longeſt and thickeſt furs are neceſſarily the warmeſt. It alſo appears from this, that the attraction between the air and theſe ſubſtances is ſo great, that in many amphibious animals, ſuch as the beaver and otter, it defends the body of the animal at the ſame time from being wet, and from being robbed of its heat by the ſurrounding fluid.

The ſnows which cover the ſurface of the earth in winter, prevents the piercing winds from the polar regions from being heated at the expence of the earth; and it is only when they come in contact with the waters that they gain that portion of heat which the ſnow prevented them obtaining from the earth. Sir Benjamin conjectures that one of the important uſes derived from the ſeas, and from the great proportion which they bear to the dry land, is the heating or cooling the winds, which at certain periods blow from the great continent.

The wiſdom and goodneſs of Providence have often been called in queſtion with regard to the diſtribution of land and water upon the ſurface of our globe, the vaſt extent of the ocean having been conſidered as a proof of the little regard that has been paid to man in this diſtribution. But, the more light we acquire relative to the real conſtitution of things, and the various uſes of the different parts of the viſible creation, the leſs we ſhall be diſpoſed to indulge ourſelves in ſuch frivolous criticiſms.

V. *A new Suſpenſion of the Magnetic Needle, intended for the Diſcovery of Minute Quantities of Magnetic Attraction: alſo an Air Vane of great Senſibility; with New Experiments on the Magnetiſm of Iron Filings and Braſs.* *By the Rev.* A. BENNET, *F.R.S.*

THE Magnetic needle is either generally made to reſt horizontally on ſharp-pointed wires, or according to Mr. Cavallo's improvement is ſuſpended by links of horſe-hair, or according to ſome others by ſilk, or fine threads.

After conſidering each of the above methods, and trying ſome of them in November, 1789, I ſuſpended a ſmall ſewing needle, by means of a ſpider's thread, in the cylindrical glaſs of my gold-leaf electrometer; and having ſatisfactorily proved its magnetic ſenſibility, I now venture to propoſe this kind of ſuſpenſion, as being well adapted to experiments requiring the needle to move with the leaſt reſiſtance.

Experiment I. Shews that a ſpider's thread only two inches long, after being twiſted 300 times does not cauſe the needle to deviate in any ſenſible degree from the magnetic meridian.

Experiment II. A piece of fine harpſicord wire, three inches long, being rendered magnetic by making it red hot, and allowing it to cool in the direction of the magnetic meridian, was ſuſpended to a ſpider's thread three inches long. This wire was turned more than a thouſand times, yet when allowed to reſt ſhewed no ſenſible deviation.

Experiment III. To the inferior extremity of a fine ſpider's thread, the upper end of which was attached to the ſpindle of a wheel uſed for ſpinning flax, was faſtened one fibre of the feather of a gooſe quill. After more than 18,000 revolutions the thread was ſhortened about one inch, yet it did not deviate from the ſituation in which it was ſtopped. It broke after 500 revolutions more.

Experiment IV. A ſpider's thread ſomewhat ſtronger than the laſt, after being turned 4800 revolutions, did not prevent a briſtle which had been attached to its inferior extremity, to point to any warm ſubſtance, whether it was with, or againſt the direction of the twiſt.

Experiment V. VI. and VII. Shews how well this ſubſtance allows very light bodies, ſuch as the down of dandelion, to evince their ſuſceptibility to the influence of heat. The down of the dandelion being faſtened to one end of a bit of gold wire, ſuſpended by the ſpider's thread, and the whole being placed under a glaſs cylinder, the down uniformly pointed to any warm bodies, and receded from cold ones. This happens from the current of air, to that part of the receiver neareſt the warm body.

Experiment IX. Shews that the ſpider's thread allows much greater freedom of motion than the rings of horſe-hair recommended by Mr. Cavallo.

Experiment X. Shews that light even when condenſed by a lens, had no effect on the vane.

Experiment XI. Shews that the ſpider's thread is unfit to be uſed as an electrometer, owing to the difficulty with which it changes its ſtate of electricity.

Experiment XII. It is indiſpenſibly neceſſary that a magnetic needle, intended for the diſcovery of minute quantities of magnetic attraction, ſhould be incloſed in a proper apparatus, that the motion of the air may not diſturb it, and that the ſubſtances to be tried may be brought ſufficiently near, and at right angles with the point of the needle. The following inſtrument was conſtructed for this purpoſe, and is ſubmitted to the approbation of thoſe who are deſirous of making further improvements in the ſcience of magnetiſm. In Plate VI. fig. 3. A is the bottom of the inſtrument, 5½ inches ſquare, and one inch thick, to lie horizontally on the table, and made of mahogany. B B is a frame of the ſame wood, ſtanding vertically on the middle of the ſquare bottom, 6½ inches high, and 5½ broad. On one ſide of the frame a piece of glaſs is fixed, and a piece of writing paper, gold beater's ſkin, or other thin ſubſtance, is paſted to the edge of the frame on the other ſide, ſo that the glaſs and the paper ſtand vertically and parallel to each other, at the diſtance of about half an inch, which is ſufficient room for the needle, hanging by a ſpider's thread from the ſcrew at C, which ſcrew paſſes through the top piece D, which drops into an opening cut through the frame, and may be taken out by means of the knob of the ſcrew at E. About 10 degrees of a circle are marked upon a bit of ivory faſtened to the edge of the frame at F, and the needle, three inches long, is made of the ſmalleſt ſteel harpſicord wire, and is ſuſpended by a ſpider's thread, alſo three inches long. A ſmall tapering hair, faſtened to the north pole with varniſh, and extending about $\frac{1}{8}$ of an inch farther than the end of the wire, points at the degrees on the ivory, ſo that its motion may be very accurately diſtinguiſhed, and eſpecially by the uſe of a lens. Round the middle of the needle a ſmall gold wire is twiſted, and its end ſtanding perpendicularly is faſtened to the ſpider's thread, to keep the needle in a horizontal poſition.

The method of obtaining and faſtening the ſpider's thread, which I have uſed, is this:—I take a forked ſtick, conſiſting of a ſtem and two or three branches, ſtanding at about ſix inches aſunder at their ends, and after finding a proper thread, in the corner of a building, or amongſt trees, the ends of the ſtick are ſmeared with varniſh, and each end applied to the thread, which being turned round the ends of the ſtick, may be brought away: or ſeveral forked ſticks may be placed in a room, where ſpiders are not diſturbed, and they will ſoon attach their threads to them.

When the thread is in this manner extended between the branches, the ſtick is placed upon the edge of a table, and in the ſunſhine, if poſſible, that it may be in a convenient poſition for attaching it to the needle and ſcrew, by which it is to hang. The gold wire above mentioned is then dipped in varniſh, and applied to one end of the ſpider's thread, ſo as to entangle it in the varniſh, which ſoon drying, the thread becomes faſt, and may be ſuffered to hang down, the upper end of the thread being yet faſt to the forked ſtick. The point of the ſcrew in the top piece is then dipped in varniſh, and the upper end of the thread attached to it in the ſame manner. Laſtly, the needle is gradually lowered through the opening in the top of the inſtrument, till it hangs oppoſite to the marked ivory: but if the thread be too long, it is eaſily ſhortened, by lifting up the top piece, touching the end of the ſcrew with varniſh, and turning it round, ſo as to wind the thread about it, till it will hang near the edge of the ivory: but to ſet the point of the hair at the end of the needle at a more exact diſtance, after the top piece is replaced, the ſcrew is turned by its knob E, which raiſes or lowers the needle till it hangs right. A ſecond method of raiſing or lowering the needle, with leſs trouble in the conſtruction, is to uſe a ſmall braſs wire inſtead of the ſcrew, which may paſs through a cork; or the ivory index may be made to riſe and fall by means of a ſcrew. If both ſides of the inſtrument be made of glaſs, it may be filled with ſome tranſparent fluid, which will not cauſe the metal to ruſt, as ſpirit of wine, or oil of turpentine, that the needle may move more ſteadily, and not be ſenſibly influenced by heat.

Expedients for rendering the inſtrument more portable might be eaſily contrived: but I hope no unprejudiced philoſopher will pronounce it uſeleſs, becauſe the ſpider's thread, which is ſo eaſily replaced, may break; for ſenſibility is the only property of eſſential uſe in diſcoveries wherein a ſmall degree of magnetic attraction is to be aſcertained.

Experiment XIV. Shews that the increaſed attraction of iron filings by efferveſcence with diluted vitriolic acid, as diſcovered by Mr. Cavallo, does not depend on any change produced by the action of the acid, but only by their occupying a greater perpendicular height during the efferveſcence.

Experiment XVI. Was made to obviate a doubt of Mr. Darwins, whether inflammable air is magnetic. The experiment proved it not to be ſo.

Experiment XVII. and XVIII. Shews that braſs is only magnetic, in conſequence of ſome particles of iron which it may contain. Theſe particles alſo may be ſo few that they do not evince their magnetic powers till the piece has been hammered.

VI. *Part of a Letter from Mr.* MICHAEL TOPPING, *to Mr.* TIBERIUS CAVALLO, *F.R.S.*

DEAR SIR, *Madras, February* 4, 1789.

I INCLOSE you an account of a baſe line I have meaſured for a ſeries of triangles I am carrying down the coaſt of Coromandel. I have already extended them to about 300 miles from Madras, and am upon returning back to proſecute the work quite down the Cape Comorin. The angles are all taken with my Hadley's ſextant, made by Stancliffe, by means of three tall ſignals I have conſtructed of bamboos, 80 feet high, 60 of which I mount upon ſteps, ſo as to ſee (over all trees, &c.) very diſtinctly my two other ſignals, at the diſtance of from 8 to 13 miles. It is, I believe, the firſt time the Hadley was ever made uſe of for a purpoſe of ſuch magnitude; but it is fully equal to it---nay, it does more---the ſun's bearing, or oblique diſtance, from my ſignals is alſo taken by it; by which, and his azimuth (computed) I obtain the angles made by them with the meridian; and by combining the whole, the difference of latitude, and meridional diſtance of every one of them in Engliſh fathoms. This is found ſo nicely, that a mean of my aſtronomical obſervations for the latitude, never differs more than a few ſeconds from thoſe given by the geometrical menſuration. In all the operations I have had no one to aſſiſt me, except a party of black fellows to carry my flags. I need not tell you how many thouſand miles I have travelled to take the angles; nor what the labour and fatigue of ſuch a work muſt be in this burning climate, where I have frequently had the thermometer at 106° in my tent.

(Signed) M. TOPPING.

I began my work for the baſe line, by placing two of my large ſignals at about ſeven miles aſunder for the extremities of it, and for greater convenience in point of ſituation, I divided the whole into ſix diſtinct portions, each portion forming a large angle with the next portion to it, and this I immediately did by placing five leſſer flags at convenient intervals.

I provided two rods of 25 feet each, and adjuſted their length by a capital two feet braſs ſector, by Adams, as a ſtandard, the thermometer at that time was 87°, they had been left purpoſely a little too long, as I found it eaſier to determine and allow for ſuch exceſſes than to reduce them to a ſufficient exactneſs.

The ſum of the ſix meaſured lines amounted, by the firſt trial, to *ſeven hundred double rods, twenty feet ſix inches and a half*; and by the ſecond, to *ſeven hundred double rods, twenty-two feet eleven inches and a half*; their difference being *two feet four inches and a half*, by which the ſecond meaſurement exceeded the firſt. The ſhorteſt of theſe meaſures is made uſe of, as operations of this nature have always a tendency to exceſs, rather than deficiency.

Beſides this *linear meaſurement*, ſeven eſſential angles were taken (each angle ſeveral times over, for ſecurity) with an excellent theodolite by Ramſden. Theſe were the angles formed, at each extremity of the baſe, by the neareſt intermediate flag, and the remote ſignal; and thoſe formed at each intermediate flag, by the neareſt flag to it, on each hand.

The nature and purport of all this will be eaſily underſtood, by inſpecting the accompanying figure, Plate VI. Fig. 4. to the following explanation.

Let N and S repreſent the northern and ſouthern ſignals, placed at each extremity of the baſe line NS.

Let ABCDE repreſent the poſitions of the five intermediate flags, between each of which, including the two ſignals, the ſix right lines, before mentioned, were meaſured.

At each of theſe points the angle formed by the flag, or ſignal, on each ſide of it, was taken with the theodolite: for inſtance, at A, the angle formed at that point by the northern ſignal N, and flag B (177° 24′ 40′); at B, the angle formed by the flags A and C (176° 23′); and ſo on. At each end of the baſe line, the angle formed by the neareſt flag and the diſtant ſignal was alſo taken; *e. g.* at N, the angle SNA, and at S, the angle NSE.

Theſe things being premiſed, to find the angles the other four lines make with the baſe line, proceed in the following manner:---Produce the line NA to K; alſo the line BA to H; and, through the point A, draw FG parallel to NS, the baſe line. From the points ABCDE let fall perpendiculars upon the baſe line, meeting it at OPQR and T.

From this conſtruction and the principles of plane trigonometry find NO. OP. PQ. QR. RT. and TS. the ſum of which taken together will be the meaſure of the baſe line NS.

Suppoſing no imperfection in the inſtrument with which the angles have been taken, and no error (however ſmall) committed in taking the ſix preceding angles, then the angle XES, obtained by this method, will prove exactly equal to the angle NSE, which may be had by obſervation. In the preſent inſtance their difference amounts to no more than 2′ 5″.

In order to obtain as great preciſion as poſſible, the intermediate angles have been deduced from both ends; thoſe at A and B, from the obſervation at N; and the remaining ones at C D and E, from that at S. Had, however, this precaution been neglected, the error induced, by deriving the four required angles from either primitive, at N or S, would not have affected the true length of the whole baſe line more than 0,27 of a foot.

This method of obtaining the meaſure of an inacceſſible line, where the meaſured lines every where make ſmall angles with it, is a very accurate one; for though, in oblique triangles, ſmall angles, from the difficulty of taking angles perfectly, are likely to produce conſiderable errors, in right-angled triangles it is the very reverſe; as in them the ſmaller the angle taken, the more accurate will be the reſult.

TABLE of the Six Meaſures with the Reductions.

Diſtance between the ſtations. Double Rods	ft.	in.	ft. in.	Rod A = +0,10 Rod B = +0,12 Corrections	Correct lengths	Angular points	Angles	Reductions Feet
N to A 146.	9.	4	7309. 4	—2. 8,1	7306. 7,9	at N	5°. 36′. 30″W	7271,68 = NO
A to B 170.	17.	6	8537. 6	—3. 1,5	8534. 4,5	A	3. 1. 10 W	8522,53 = OP
B to C 106.	11.	6	5311. 6	—1. 11,4	5309. 6,6	B	0. 35. 30 E	5309,26 = PQ
C to D 83.	10.	3	4160. 3	—1. 6,4	4158. 8,6	C	2. 32. 30 E	4154,63 = QR
D to E 93.	8.	2	4658. 2	—1. 8,5	4656. 5,5	D	3. 55. 0 E	4645,59 = RT
E to S 100.	43.	5,7	5043. 5,7	—1. 10,2	5041. 7,5	S	6. 53. 0	5005,29 = TS
							Total	34908,98 = NS

Or rejecting the decimals, 11636 Yards = 6 Miles 4 Feet 196 Yards = the Baſe

The greateſt reſult of five ſets, of ſix obſervations, each with the theodolite, the angle between the baſe line and the meridian is,	3°. 33′. 18″
The leaſt,	3. 25. 28
Mean of the whole	3. 29. 12
The mean reſult computed from ſun's meaſured diſtance and altitude, from four obſervations, with Hadley's quadrant	3. 27. 40
Ditto from three	3. 28. 6
Mean of the whole gives baſe	N 3. 28. 39E

From which it appears that Hadley's is by far the beſt inſtrument for ſuch purpoſes.

The greateſt reſult of the latitude of the South end of the baſe, from meridional obſervations of thirteen ſtars	11°. 33′. 48″
The leaſt,	11. 32. 43
Mean of the whole,	11. 33. 22
From the length of the baſe, and its bearing the dif. of. lat. is	+ 5. 42
Latitude of North end,	11. 39. 4

Having compleated the meaſurement and principal calculations, I cauſed a large ſtone to be placed at each extremity of the baſe, to mark and perpetuate it for future occaſions. The ſtone at the North end I inſcribed with the following characters:

S. 3° 29′ W.
Yds.
11636.
T.
1788.

And that at the South end as follows:

N. 3° 26′ E,
Yds.
11636.
T.
1788.

both inſcriptions equally implying, that the oppoſite end of the baſe line lies in the direction therein expreſſed, diſtant 11636 Engliſh yards from the ſtone ſo inſcribed.

It may be proper to record, that the North end of the baſe is on the ſea beach, 27 yards from the ſurf; and 129 yards N. E. by E. eaſterly, from an old choultry in a Palmyra tope, called Namaſwaumoodaly Choultry. From the mouth of Cuddalore river to the North end of the baſe I meaſured, with a perambulator, juſt four miles and one furlong.

The South end of the baſe lies 42 yards from the ſurf, and 169 yards E.½S. from a decayed choultry, in a Palmyra tope, called Chinnachitty choultry. There is another choultry and tope near the centre of the baſe; but the northern cluſter of trees before mentioned, is the firſt cluſter we meet with, by the ſea ſide, ſouthward of Cuddalore river.

This meaſured baſe makes the exterior ſide of the thirty-third triangle of a concatenated ſeries of oblique triangles, now carrying down the coaſt from the ſteeple of Fort Saint George.

VII. *Deſcription of Kilburn Wells, and Analyſis of their Water.* By *Mr.* JOH. GODFR. SCHMEISSER.

THOSE wells lie to the right of the Edgeware Road, about two miles from London, in a dry, but verdant, and gently riſing meadow.

They ſpring about 12 feet below the ſurface, and are covered with a ſmall ſtone cupola.

The diameter of the well near the ſurface of the water is about five feet; the depth of the water was July and Auguſt two feet; this its general depth increaſes in winter, at times, to three feet; the changes in the atmoſphere do not appear to affect either the quantity or quality of the water.

This mineral water is not perfectly bright, but of rather a milky hue; it has a mild and bitteriſh taſte, with little or no briſkneſs, as containing a very ſmall proportion of fixed air. On dipping for the water, or otherwiſe agitating it, a ſulphureous ſmell is perceived near the ſurface; which, however, ſoon goes off in a temperature of about 80 degrees of Fahrenheit's thermometer, *which I have uſed throughout.*

The ſpecific gravity of the Kilburn water is to diſtilled water as 1,0071 : 1,0000; its general temperature 53°, which was not affected by a change of 10 degrees in the temperature of the atmoſphere. While the water continues at reſt, no ebullition of fixed air is perceived, and ſcarce any ſulphureous ſmell.

That this mineral water ſo eaſily parts with the hepatic air (perceivable on agitating it) if it be ſhaken in a warmer temperature, or tranſported from one place to another, is probably owing to the fixed air which it contains: for as this aerial acid has a great affinity to phlogiſton; ſo it may hence be inferred, that fixed and hepatic air cannot exiſt together in a mineral water, but that the latter will be deſtroyed, as the fixed air is developed by gentle warmth.

From the experiments it appears that the contents are as follow:

Summary of the Conſtituent Parts of the Kilburn Water, in 24 Pounds.

Fixed air - - - - - -	84	cubic inches		
Hepatic - - - - near	36			
Vitriolated magneſia - -	910	grains, equal to ℥ij ʒiiss, Apothecary's weight.		
Vitriolated natron - - -	282	gr.	=	ʒv. lij grains
Muriated natron - - -	60	gr.	=	75 gr.
Selenite - - - - - -	130	gr.	=	ʒij xlij gr.
Muriated magneſia - -	128	gr.	=	ʒij xl gr.
——— calcareous earth -	6	gr.	=	7½ gr.
Aerated magneſia - - -	12½	gr.	=	15 gr.
——— calcareous earth -	24	gr.	=	30 gr.
Calx of iron - - - -	3⅛	gr.	=	4 gr.
Reſinous matter - - -	6	gr.	=	7½ gr.

Sum 1561⅝ grains, equal to medicinal
weight 4 ounces, 0 drams, and
32 grains.

Two quarts of the water operated as a gentle purgative, and at the ſame time affected the head a little. But this ſpecies of intoxication was not felt, if the water had been firſt deprived of the hepatic air.

A piece of ſilver having been placed in the axilla was tinged black in leſs than half an hour after drinking the water.

VIII. *Obſervations on Bees.* By John Hunter, *Eſq. F.R.S.*

THE writer begins with ſome general obſervations concerning the mode of deſcription in natural hiſtory, in which he cenſures Swammerdam for unneceſſary minuteneſs. He then remarks the uſe of analogy in ſtudying the economy of animals, by which, unavoidable obſcurities in ſome ſubjects, are cleared up by demonſtrations drawn from others. The uſe of this aſſiſtance is evident in the whole hiſtory of flying inſects, where much muſt be loſt in individual ſpecies, for want of the power of aſcertaining it.

In treating on the bee, he means only to conſider thoſe peculiarities which conſtitute its difference from other inſects. As they are animals which from their numbers hide many of their operations, the contrivance of glaſs hives is neceſſary to obſerve them. Theſe (Mr. Hunter ſays) ſhould be thin, the diſtance from ſide to ſide about three inches, of height and length ſufficient for a ſwarm to complete one ſummer's work in. One perpendicular comb from top to bottom in the centre being the moſt convenient for the view, a ridge ſhould be made at the top for them to begin their work from. In order to view the operations of particular parts, it is uſeful to have different panes opening with hinges.

Bees are ſome of the moſt univerſal of animals; and from their providing for change of ſeaſon, would ſeem adapted for changeable climates; yet they appear to thrive beſt in a pretty warm one. They are irritable and jealous of common property, but not covetous or diſpoſed to obſtruct each other. They are perhaps the only inſect that feeds in the winter; and therefore do not grow fat in the ſummer like other animals, which depend upon internal ſtores in their torpid ſtate during winter.

Of the Heat of Bees. Bees are, perhaps, the only inſect that produces heat within itſelf. By the thermometer it was found that on July 18, heat of the open air 54, that of a bee-hive was at different hours from 78 to 84 :---on December 30, air at 35, bees at 73. Bees are eaſily affected by cold when ſingle, and to avoid it, form cluſters. They are likewiſe enemies to wet; and their ſenſibilities with reſpect to the approach of both are very ſtrong. Their eggs require heat as much as themſelves; nor will the maggot, or even the chryſalis, live in a cold of 60 or 70. A perſpiration is often found on the inſide of glaſs hives. They are very cleanly animals, ſeldom or never diſcharging their excrements in the hive.

The ſociety of bees conſidered individually, conſiſts of a female breeder, of female non-breeders, and males; but conſidered as a community, the males cannot be reckoned, as only ſerving for the temporary purpoſe of generation. The female-breeder, alſo, may probably be regarded in no other light than that of a layer of eggs; yet ſhe ſeems to keep the whole ſociety together by a common attachment, that of young to their mother. Mr. Hunter therefore acquieſces in the name of queen given to her, though without allowing her any voluntary influence or power.

The hiſtory of bees may be begun from various points; he prefers that of forming a new colony, or ſwarming. This appears to be an operation of neceſſity; for if the hive is large enough, they do not ſwarm. A ſwarm conſiſts of a female or females, (Mr. Hunter thinks never more than one), males, and mules or labourers; the whole number about ſix or ſeven thouſand. They generally ſoon appear directed to ſome fixed place, but ſometimes they ſeem to wander in uncertainty. They ſettle on a branch, in the cavities of old trees, or holes of buildings leading to a hollow place. There are commonly two, ſometimes three ſwarms in a ſummer, but ſucceſſively weaker. Bees ſometimes ſeem about to ſwarm, but do not.

The firſt care of the new colony when fixed, is to prepare a dwelling, which is their comb. This is made of wax, reſpecting the production of which Mr. Hunter gives a new account. It is not a matter exiſting in the farina of flowers, as *Reaumur* ſuppoſed, or ready formed elſewhere in vegetables; but is a ſecretion of the bee, exuding between each ſcale of the under ſide of the belly. Theſe ſcales of wax Mr. Hunter has taken and melted in the candle, when they ran into a globe. They may be found lying at the bottom of the hive, but he could not detect the bees in the act of detaching them from their bodies.

The cells which compoſe the comb, form perpendicular plates or partitions, extending from top to bottom, and from ſide to ſide, of the cavity in which they are built. The bees begin at the roof of the vault, and work downwards. Each plate conſiſts of a double ſet of cells, whoſe bottoms form the partition between them. The plates are not very regularly arranged, but often are accomodated to the ſhape of the cavity. The cells are of unequal depth; but as the breeding cells muſt be of a given depth, they reſerve a ſufficient number for this purpoſe, and put the honey into the others. Paſſages are formed between the combs and the cavity, and alſo in the middle of the plates. The ſubſtance uſed for attaching the combs, is not the ſame with common wax, but ſofter and tougher, and probably a mixture of wax with farina. The cells are placed nearly but not exactly horizontally. The firſt combs formed by a hive, are the ſmalleſt and neateſt; their ſides thinner, their hexagon more perfect, and their wax purer, than the lower.

Of the Royal Cell. Of theſe there are often three or four, ſometimes as many as 11 or 13, in the ſame hive. They are commonly placed on the edge of a comb, though ſometimes on the ſide, but not in the centre along with the other cells. The royal cell is much wider than the others, but ſeldom ſo deep. Its mouth is round. It is compoſed of materials ſofter than common wax, conſiſting of leſs than one third wax, the reſt probably farina. Mr. Hunter thinks it a miſtake to ſuppoſe that the queen is bred in this cell.

The comb ſeems primarily formed for propagation, and the reception of honey to be a ſecondary uſe; for if the bees loſe their queen, they make no combs; and other inſects of the bee tribe make combs though they do not lay up honey. In the conſtruction of their cells, Mr. Hunter conſiders the bees as under the influence of an inſtinctive principle, not allowing variation but from external neceſſity. The more imperfect and clumſy formation of the laſt made cells, is apparently owing to the inferior purity of the wax. The bees ſeem to reſerve many of their cells for honey, and thoſe moſtly at the upper part.

Of the laying of Eggs. The female bee begins laying as ſoon as a few combs are formed. As far as Mr. Hunter has obſerved, the queen alone propagates, though others have aſſerted that the labourers do likewiſe. The firſt eggs are thoſe which produce the labourers; then the males, and probably the queen. The eggs are laid at the bottom of the cell, and they are found there before the cells are half compleated. The egg is attached at one end, and has a ſlimy covering. There ſeems to be a period in which the great buſineſs of laying eggs is effected. The complete proceſs of the egg, from laying to hatching, and the life of the maggot and of the chryſalis, ſeems ſhorter than in moſt inſects. Mr. Hunter has been led to ſuppoſe that the eggs are hatched in five days. The young maggot is found lying coiled up in the bottom of the cell, in ſome meaſure ſurrounded with a tranſparent fluid. The labouring bees have now the additional employment of feeding the young maggot, in which they are eaſily detected. The maggots caſt their coats as they grow; and the bees often ſhift them from cell to cell, as they alſo do the eggs. When grown ſo as nearly to fill the cell, they require no more food, but are fit for the chryſalis ſtate. The incloſure for this ſtate, which in all other known inſects is the work of the caterpillar itſelf, is here effected by the perfect animal. The bees cover the mouth of the cell with a ſubſtance of a light brown colour, that ſeems to be a mixture of wax and farina. The maggot thus encloſed, ſpins itſelf a kind of pod with a ſilk lining the cell and its cover; and then puſhing off its laſt maggot-coat, it becomes a chryſalis. The time between rhe maggot's being hatched, and encloſed, appears to be four days.

Of the Food of the Maggot, or what is commonly called Bee-Bread. This ſubſtance, which is certainly the food of the maggot of the humble-bee, and of other kinds, is probably ſo of that of the common bee. It is at all times found in the hive, and is often depoſited in cells and covered with wax, as the honey. It is commonly compoſed of layers of different colours. This is the ſubſtance that the bees bring on their legs, and it conſiſts of the farina of plants, but not indifferently taken from all plants. Their mode of depoſiting it in the cells is curious. They walk along the combs till they come to the cell they chuſe, and then dropping their hind legs and tail or belly into it, they turn the point of the tail to the outſide of the leg where the farina is, and ſhove it off. When the bee has thus ſhoved it off both legs, and left it, another bee comes, and deſcending into the cell kneads and works it into the bottom, leaving a ſmooth ſurface. The conſiſtency of the bee-bread is like paſte; it burns ſlightly, and gives a ſingular ſmell. If a maggot full grown be killed, its ſtomach is found filled with a matter ſimilar to this, but ſofter, as if mixed with the juices of the ſtomach.

The maggots diſcharge very little excrement, and it is never cleared away by the bees, but ſuffered to dry with the caſt coats, and both freſh eggs and honey are depoſited in the ſame cells.

Of the Chryſalis ſtate. This continues 13 or 14 days, during which a complete change is effected in their form, and then the perfect bee burſts its covering and comes forth.

Of the ſeaſons when the different operations of Bees take place. The new colony immediately ſets about building their apartments, laying eggs, and rearing the young. When this is done, the ſeaſon for collecting honey commences. As ſoon as a cell is filled, it is covered over with pure wax for a winter ſtore. This both keeps the honey from ſpilling, and prevents its evaporation. They alſo lay up bee-bread for the maggots in the ſpring. In Auguſt the queen or queens may be ſuppoſed to be impregnated by the males. The males ſoon after are attacked by the labourers, and pulled about and pinched, not ſtung, till they die. When all the young are come forth, and either the cells filled with honey, or no more to be collected, the bees remain in their hives for the winter. As they are very ſenſible of cold, they become ſtill and quiet, and get into a cluſter. They will however go a broad in a fine day, at which time they get rid of their excrement, which they ſeem to retain while in the hive. They now ſubſiſt on the fruits of their ſummer's induſtry, and they ſeem to feed in proportion to the coldneſs of the ſeaſon. The following table ſhows the reſult of an experiment of the weekly loſs of weight of a hive during a winter. The hive was weighed November 3d. 1776. It had loſt on

		oz.	dr.			oz.	dr.
November	10, - -	2	7	December	29, - -	5	4
	17, - -	4	2½	January	5, - -	2	5
	24, - -	3	7½		12, - -	5	2
December	1, - -	8	2		19, - -	3	4
	8, - -	2	1		26, - -	3	1½
	15, - -	5	2	February	2 - -	5	0
	22, - -	4	3		9 - -	7	0
					Total -	72	1½

During winter the eggs in the oviducts of the queen begin to ſwell, and ſhe is probably ready to lay them in March, which is earlier than any other inſect. In April the cells were found to contain young in all ſtages from the egg to the chryſalis, and ſome newly arrived to the fly ſtate. The ſtock of farina now comes into uſe; but as ſoon as the flowers begin to blow, the bees gather freſh.

Of the Queen. Much curioſity has been excited concerning her hiſtory, and many ingenious conjectures have been formed to ſupply the place of obſervation. One of the moſt remarkable opinions, and that ſaid to be confirmed by experiment, is that the labourers have the power of converting a common maggot into a queen. Abſtracts from Mr. *Schirach's* account of theſe experiments are here given, with objectional notes by Mr. Hunter, who aſſerts his doubts reſpecting the whole of them, founded on ſeveral circumſtances which occurred in his own obſervations. The queen, however formed, is a true female. She is not ſo large in the trunk as a male, but rather longer in all parts than the labourers. Her belly is lighter than that of the labourers, and her tongue ſhorter. The ſize of her belly differs according to her condition; in ſpring and ſummer it is thicker and conſiderably longer than formerly, from the increaſe of the eggs. She may be diſtinguiſhed from a working bee ſimply by ſize, and in ſome meaſure by colour, but the laſt is not eaſily diſcovered, as it is chiefly in the under part. She is furniſhed with a ſting.

Of the number of Queens in a Hive. Mr. Hunter has never found more than one in a ſwarm, or in an old hive in the winter; and ſuppoſes that where there are two, a diviſion is likely to take place. That there are ſo few queen-bees bred, whereas among waſps and hornets there are hundreds in a neſt, he conceives to be owing to their greater ſecurity from the ſtate of ſociety in which the bees live. With reſpect to the mode of impregnating the queen, or her eggs, various opinions have been given, but founded on conjecture only. Mr. Hunter thinks it probable that the copulation is like that of other inſects. He has ſeen that of the humble-bee, which is ſimilar to that of the common fly.

Of the Male Bee. This is conſiderably larger than the labourers, and even larger than the queen, though not ſo long when ſhe is full with egg. He is thicker in proportion, and does not terminate in ſo ſharp a point. His proboſcis is much ſhorter than that of the labouring bee; whence it may be ſuſpected that he does not collect his own honey, eſpecially as the males are never found on flowers, but only flying about the hive in hot weather, as for an airing. He is without ſting. The males are probably later bred than the labourers, as they are only produced to go off with a ſwarm. In April no males were found among the chryſaliſes, but about May 20th they were obſerved. About the end of Auguſt they may be ſuppoſed to impregnate the queen, and ſoon after in that month, and the beginning of September, they are dying, their end being haſtened by the ill treatment they meet with from the labourers. All of them undergo this fate, not one being met with in hives killed in winter, though ſome writers have ſuppoſed a ſmaller ſort preſerved to impregnate the queen.

Of the Labouring Bee. Theſe, which are by much the moſt numerous claſs, and thoſe which perform all the buſineſs of the hive, are in fact females in conſtruction, having the female parts, but ſo extremely ſmall, that a perſon not well acquainted with them in the queen, would eaſily overlook them. It might, indeed, be ſuppoſed that they were only young queens, and would at a certain age become ſuch; but this is not the caſe. Having a ſting for a weapon of offence and defence, they are very irritable, and ready to make an attack when unprovoked, upon mere ſuſpicion. But when they fight with one another they generally uſe their pincers. Their number in a hive varies conſiderably. In two hives that were killed there were 3338, and 4472; in one that died, 2432. A pint of bees, ale meaſure, was found to contain 2160, and ſome ſwarms will fill two quarts.

Of the Parts concerned in the Nouriſhment of the Bee. The bee, in common with the pigeon and ſome other birds, is a *regurgitating* animal, that is, it takes in aliment not only for its own nouriſhment, but to be returned for another purpoſe. Birds regurgitate the food for their young, but bees do it for depoſiting it in a ſtore. In none of the regurgitating animals are the reſervoirs for food, the ſame with the immediate organ of digeſtion.

"The tongue of the bee is the firſt of the alimentary organs to be conſidered: it is of a peculiar ſtructure, and is probably the largeſt tongue of any animal we know, for its ſize. It may be ſaid to conſiſt of three parts reſpecting its length, having three articulations. One, its articulation with the head, which is in ſome meaſure ſimilar to our larynx. Then comes the body of the tongue, which is compoſed of two parts; one, a kind of baſe, on which the other, or true tongue, is articulated. This firſt part is principally a horny ſubſtance, in which there is a groove, and it is articulated with the firſt, or larynx; on the end of this is fixed the true tongue, with its different parts. Theſe two parts of the tongue are as it were incloſed laterally, by two horny ſcales, one on each ſide, which are concave on that ſide next to the tongue; one edge is thicker than the other, and they do not extend ſo far as the other parts. Each of theſe ſcales is compoſed of two parts, or ſcales, reſpecting its length, one articulated with the other; the firſt of thoſe ſcales is articulated with the common baſe, or larynx, at the articulation of the firſt part of the tongue, and incloſes laterally the ſecond part of the tongue, coming as far forwards as the third articulation: on the end of this is articulated the ſecond ſcale, which continues the hollow groove that incloſes the tongue laterally; this terminates in a point. Theſe ſcales have ſome hairs on their edge.

On the termination of the ſecond part, is placed the true tongue, having two lateral portions or proceſſes, on each ſide, one within the other: the external is the largeſt, and is ſomewhat ſimilar to the before-mentioned ſcales. This is compoſed of four parts, or rather of one large part, on which three ſmaller are articulated, having motion on themſelves. The firſt, on which the others ſtand, is articulated at the edges of the tongue, on the baſis, or termination of the laſt deſcribed part of the tongue: this has hairs on its edge.

A little further forwards on the edges of the tongue are two ſmall thin proceſſes, ſo ſmall as hardly to be ſeen with the naked eye. The middle part of all, of which theſe lateral parts are only appendages, is the true tongue. It is ſomething longer than any of the before-mentioned lateral portions; and is not horny, as the other parts are, but what may be called fleſhy, being ſoft and pliable. It is compoſed of ſhort ſections, which probably are ſo many ſhort muſcles, as in fiſh; for they are capable of moving it in all directions. The tongue itſelf is extremely villous, having ſome very long villi at the point, which act, I conceive, ſomewhat like capillary tubes.

This whole apparatus can be folded up, into a very ſmall compaſs, under the head and neck. The larynx falls back into the neck, which brings the extreme end of the firſt portion of the tongue within the upper lip, or behind the two teeth; then the whole of the ſecond part, which conſiſts of five parts, is bent down upon and under this firſt part, and the two laſt ſcales are alſo bent down over the whole; ſo that the true tongue is incloſed laterally by the two ſecond horny ſcales, and over the whole lie the two firſt.

The œſophagus, in all of this tribe of inſects, begins juſt at the root of the tongue, as in other animals, covered anteriorly by a horny ſcale, which terminates the head, and which may be called the upper lip, or the roof of the mouth. It paſſes down through the neck and thorax, and when got into the abdomen, it immediately dilates into a fine tranſparent bag, which is the immediate receiver of whatever is ſwallowed. From this the food (whatever it be) is either carried further on into the ſtomach, to be digeſted, or is regurgitated for other purpoſes. To aſcertain this in ſome degree, in living bees, I caught them going out early in the morning, and found this bag quite empty: ſome time after I caught others returning home, and found the bag quite full of honey, and ſome of it had got into the ſtomach. Now I ſuppoſe that which was in the craw, was for the purpoſe of regurgitation; and as probably they had faſted during the night, part had gone on further for digeſtion. Whatever time the contents of this reſervoir may be retained, we never find them altered, ſo as to give the idea of digeſtion having taken place: it is pure honey. From this bag the contents can be moved either way; either downwards to the ſtomach, for the immediate uſe of the animal itſelf; or back again, to be thrown out as ſtore for future aliment.

The ſtomach ariſes from the lower end, and a little on the right ſide, of this bag. It does not gradually contract into a ſtomach, nor is the outlet a paſſage directly out, but in the centre of a projection which enters ſome way into the reſervoir, being rather an inverted pylorus, thickeſt at its moſt projecting part, with a very ſmall opening in the centre, of a peculiar conſtruction. This inward projecting part is eaſily ſeen through the coats of the reſervoir, eſpecially if full of honey.

The ſtomach begins immediately on the outſide of the reſervoir, and the ſame part which projects into the reſervoir, is continued ſome way into the ſtomach, but appears to have no particular conſtruction at this end; and therefore it is only fitted to prevent regurgitation into the reſervoir, as ſuch would ſpoil the honey. This conſtruction of parts is well adapted for the purpoſe; for the end projecting into the reſervoir, prevents any honey from getting into the ſtomach, becauſe it acts there as a valve; therefore whatever is taken in, muſt be by an action of this vaſcular part. The ſtomach has a good deal the appearance of a gut, eſpecially as it ſeems to come out from a bag. It paſſes almoſt directly downwards in the middle of the abdomen. Its inner ſurface is very much increaſed, by having either circular valves, ſomewhat like the *valvulæ conniventes* in the human *jejunum*, or ſpiral folds, as in the inteſtine of the ſhark, &c.; theſe may be ſeen through the external coats. In this part the food undergoes the change. Where the ſtomach terminates, is not exactly to be aſcertained; but it ſoon begins to throw itſelf into convolutions, and becomes ſmaller.

The inteſtine makes two or three twiſts upon itſelf, in which part it is enveloped in the ducts, conſtituting the liver, and probably the pancreas, and at laſt paſſes on ſtraight to the termination of the abdomen. Here it is capable of becoming very large, to ſerve upon occaſion as a reſervoir, containing a large quantity of excrement: it then contracts a little, and opens under the poſterior edge of the laſt ſcale of the back, above the ſting in the female and labourers, and the penis in the male."

Of the Senſes of Bees. There is no doubt that they enjoy all the five. Smell might be queſtioned, but the eagerneſs with which they fall upon honey in a very faint light, ſeems to prove it.

Of the Voice of Bees. They form ſeveral ſounds for different occaſions. That with which they make an attack is probably produced by the wings. But they make a kind of ſhrill peeviſh noiſe, independently of their wings, as is proved by their continuing it when the wings are held ſtill or cut off. They make a ſort of ringing, or trumpeting noiſe on the evenings before they ſwarm.

Of the Female Parts. Inſects differ from moſt of the claſſes of animals above them, in having their eggs formed in the ducts along which they paſs, not in a cluſter on the back: from thence they are taken up, and by the ducts are conveyed to their places of deſtination.

“ *Of the Oviducts.* The female of the common bee, ſimilar to all the females of the bee tribe, has ſix oviducts on each ſide, beginning by very ſmall, and almoſt imperceptible threads, as high as the cheſt: they then form one cord coiled up, or paſs very ſerpentine, and become larger and larger as they approach the anus, owing to the gradual increaſed ſize of the eggs in them, which are now more diſtinct, and give the duct a ſort of interrupted appearance, toward the lower end. The ſix ducts, when full of eggs, make a kind of quadrangle; then all unite into one duct, which enters the duct common to it and the oviducts of the other ſide. The ducts common to the ſix oviducts on each ſide, are extremely tender; ſo much ſo, that it is difficult to ſave them. The duct common to thoſe on both ſides may be called the vagina, and it is continued to the anus, or termination of the belly.

Of the Male Parts. The male parts of generation, in the common bee, are much larger than in the humble bee. This we ſuppoſe neceſſary, conſidering the vaſt number of eggs the common bee lays, more than the humble bee does.

The external parts of generation of the male bee, are rather more under the belly, than in the others of this tribe; not ſo much at the termination of the belly; and they are rather more expoſed, the two laſt ſcales, eſpecially the under one, not projecting ſo much: the two holders are not ſo projecting beyond their baſe, nor are they ſo hooked, or ſharp, as in the humble bee; hardly deſerving the name of holders. From the external parts, paſſes up into the abdomen a pretty large ſheath, whoſe termination incloſes the glans penis. It is a bulbous part, having a dark coloured horny part upon it, which has two proceſſes near its opening externally, one on each ſide, of a yellow colour: it has another proceſs, which is white, and ſeems to be a gland. It can be made to paſs along this ſheath, or prepuce, and appear externally: I have been able, with a pair of forceps, to invert the ſheath, beginning externally at the mouth, and pulling out a little at a time, by ſhifting my hold, till the glans has appeared externally.

The internal parts are the teſticles, with their appendages. The teſticles are two ſmall oblong bodies, lying near the back, having a vaſt number of air-veſſels paſſing into them, and ramifying upon them. They are of a pale yellowiſh colour. From their lower ends paſs down ducts, which may be called *vaſa deferentia*, and which enter two bags: theſe two bags, into which the *vaſa deferentia* enter, are probably reſervoirs for the ſemen. From the union of theſe two bags paſſes out a duct, which runs towards the termination of the abdomen, and ends in the penis. Theſe three parts, namely, teſticles with their ducts, the two bags, and the duct ariſing from them, which I have termed urethra, are all folded on each other, ſo as to appear as one body.

In the introduction to this account of bees I obſerved, that ſeveral things in their

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œconomy might eſcape us if we conſidered them alone, but might be made out in other inſects: an inſtance of this occurs in the impregnation of the female bee. The death of the males in the month of Auguſt, ſo that not one is left, and yet the queen to breed in the month of March, muſt puzzle any one not acquainted with the mode of impregnation of the females of moſt inſects. Inſects, reſpecting the males, are of two kinds: one, where the male lives through the winter, as well as the female: and the other, where every male of that ſpecies dies before the winter comes on; among which may be conſidered, as a third, thoſe where both male and female die the ſame year. Of the firſt, I ſhall only give the common fly as an inſtance; of the ſecond, I ſhall juſt mention all of the bee tribe; and the third may be illuſtrated in the ſilk-worm. The mode of impregnation in the firſt, is its being continued uninterruptedly through the whole period of laying eggs; while in the ſecond, the copulation is in ſtore; and, in the third the female lays up, by the copulation, a ſtore of ſemen, although the male is alive: of this I ſhall now give an explanation in the ſilk moth, which may be applied to the bee, and many other inſects.

In diſſecting the female parts in the ſilk-moth, I diſcovered a bag lying on what may be called the vagina, or common oviduct, whoſe mouth, or opening, was external, but it had a canal of communication between it and the common oviduct. In diſſecting theſe parts before copulation, I found this bag empty, and when I diſſected them after, I found it full. Suſpecting this to contain the ſemen of the male, I immediately conceived the following experiment; I opened the female as ſoon as the male had united to her, and found the penis in the opening of this bag, and by opening the duct where the penis lay, I obſerved the ſemen lying on the end of the penis. In another, I obſerved the bag to fill in the time of copulation: and in a pair that died in the act, I found the penis in this paſſage.

When we conſider the impregnation of the egg in the ſilk-worm, we may obſerve the following circumſtances:

Firſt, many of the ova are completely formed, and covered with a hard ſhell, before copulation: ſecondly, the animals are a vaſt while in the act of copulation: and thirdly, the bags at the anus are filled during the time of copulation. From the firſt obſervation it appears, that the egg can receive the male influence through the hard or horny part of the ſhell. To know how far the whole, or only a part of the eggs, were impregnated by each copulation, I made the following experiments.* I took a female juſt emerged out of her cell, and put a male to her, and allowed them to be connected their full time. They were in copulation ten hours. I then put her into a box by herſelf, and when ſhe laid her eggs, I numbered the different parcels as ſhe laid them, viz. 1, 2, 3, 4, 5; theſe eggs I preſerved, and in the ſummer following I perceived that the No. 5 was as prolific as the No. 1; ſo that this one copulation was capable of impregnating the whole brood: and therefore the male influence muſt go either along the oviduct its whole length, and impregnate the incomplete eggs, as well as the complete, which appears to me not likely; or thoſe not yet formed were impregnated from the reſervoir in the act of laying: for I conceived that theſe bags, by containing ſemen, had a power of impregnating the egg as it paſſed along to the anus, juſt as it traverſed the mouth of the duct of communication.

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* All theſe experiments on the ſilk-moth were begun in the ſummer 1767, and repeated by Mr. Bell in the year 1770.

Finding that eggs completely formed, could be impregnated by the ſemen, and alſo finding that the before-mentioned bag was a reſervoir for the ſemen till wanted, I wiſhed next to diſcover if they could be impregnated from the ſemen of this bag; but as this muſt be done without the act of copulation, I conceived it proper, firſt, to ſee whether the ova of inſects might be impregnated without the natural act of copulation, by applying the male ſemen over the ova, juſt as they were laid. The following experiments were made on the ſilk-moth:

Experiment I. I took a female moth, as ſoon as ſhe eſcaped from her pod, and kept her carefully by herſelf, upon a clean card, till ſhe began to lay; then I took males that were ready for copulation, opened them, expoſing their ſeminal ducts, and after cutting into theſe, collected their ſemen with a hair pencil: with this ſemen I covered the ova, as ſoon as they paſſed out of the vagina. The card with theſe eggs, having a written account of the experiment upon it, I kept in a box by itſelf. In the enſuing ſeaſon, eight of the ova hatched at the ſame time with others naturally impregnated. Thus, then, I aſcertained that the eggs could be impregnated by art, after they were laid.

The ova laid by females that had not been impregnated, did not ſtick where they were laid: ſo that the ſemen would appear not only to impregnate the ova, but alſo to be the means of attaching them.

To know whether that bag in the female ſilk-moth, which increaſed at the time of copulation, was filled with the ſemen of the male, I made the following experiment:

Experiment II. I took a female moth, as ſoon as ſhe had eſcaped from the pod, and kept her on a card till ſhe began to lay. I then took females that were fully impregnated before they began to lay, and diſſected out that bag which I ſuppoſed to be the receptacle for the male ſemen; and wetting a camel hair pencil with this matter, covered the ova as ſoon as they paſſed out of the vagina. Theſe ova were laid carefully on the clean card, and kept till the enſuing ſeaſon, when they all hatched at the ſame time with thoſe naturally impregnated.

This proves that this bag is the receptacle for the ſemen, and gradually decreaſes as the eggs are laid.

Of the Sting of the Bee. I have obſerved that it is only the queen and the labourers that have ſtings; and this proviſion of a ſting is perhaps as curious a circumſtance as any attending the bee, and probably is one of the characters of the bee tribe.

The apparatus itſelf is of a very curious conſtruction, fitted for inflicting a wound, and at the ſame time conveying a poiſon into that wound. The apparatus conſiſts of two piercers, conducted in a groove, or director, which appears to be itſelf the ſting. This groove is ſomewhat thick at its baſe, but terminates in a point; it is articulated to the laſt ſcale of the upper ſide of the abdomen by thirteen thin ſcales, ſix on each ſide, and one behind the rectum. Theſe ſcales incloſe, as it were, the rectum or anus all round; they can hardly be ſaid to be articulated to each other only attached by thin membranes, which allow of a variety of motions; three of them, however, are attached more cloſely to a round and curved proceſs, which comes from the baſis of the groove in which the ſting lies, as alſo to the curved arms of the ſting, which ſpread out externally. Theſe two ſtings may be ſaid to begin by thoſe two curved proceſſes at their union with the ſcales, and converging towards the groove at its baſe, which they enter, then paſs along it to its point. They are ſerrated on their outer edges, near to the point. Theſe two ſtings can be thruſt out beyond the groove, although not far, and they can be drawn within it; and, I believe, can be moved ſingly. All theſe parts are moved by muſcles, which we may ſuppoſe are very ſtrong in them, much ſtronger than in other animals; and theſe muſcles give motion in almoſt all directions, but more particularly outwards. It is wonderful how deep they will pierce ſolid bodies with the ſting. I have examined the length they have pierced the palm of the hand, which is covered with a thick cuticle: it has often been about $\frac{1}{12}$ of an inch. To perform this by mere force, two things are neceſſary, power of muſcles, and ſtrength of the ſting; neither of which they ſeem to poſſeſs in ſufficient degree. I own I do not underſtand this operation. I am apt to conceive there is ſomething in it diſtinct from ſimple force applied to one end of a body; for if this was ſimply the caſe, the ſting of the bee could not be made to pierce by any power applied to its baſe, as the leaſt preſſure bends it in any direction it is poſſible the ſerrated edges may aſſiſt, by cutting their way in, like a ſaw.

The apparatus for the poiſon conſiſts of two ſmall ducts, which are the glands that ſecrete the poiſon: theſe two lie in the abdomen, among the air-cells, &c. they both unite into one, which ſoon enters into, or forms, an oblong bag, like a bladder of urine; at the oppoſite end of which paſſes out a duct, which runs towards the angle where the two ſtings meet; and entering between the two ſtings, is continued between them in a groove, which forms a canal by the union of the two ſtings to this point. There is another duct on the right of that deſcribed above, which is not ſo circumſcribed, and contains a thicker matter, which, as far as I have been able to judge, enters along with the other: but it is the firſt that contains the poiſon, which is a thin clear fluid. To aſcertain which was the poiſon, I dipped points of needles into both, and pricked the back of the hand; and thoſe punctures that had the fluid from the firſt-deſcribed bags in them grew ſore and inflamed, while the others did not. From the ſtings having ſerrated edges, it is ſeldom the bees can diſengage them; and they immediately upon ſtinging endeavour to make their eſcape, but are generally prevented, as it were caught in their own trap; and the force they uſe commonly drags out the whole of the apparatus for ſtinging, and alſo part of the bowels; ſo that the bee moſt frequently falls a ſacrifice immediately upon having effected its purpoſe. Upon a ſuperficial view, one conceives, that the firſt intention of the bee having a ſting is evident; one ſees it has property to defend, and that therefore it is fitted for defence, but why it ſhould naturally fall a ſacrifice in its own defence, does not ſo readily appear: beſides, all bees have ſtings, although all bees have not property to defend, and therefore are not under the ſame neceſſity of being ſo provided. Probably its having a ſting to uſe, was ſufficient for nature to defend the bee, without uſing it liberally; and the loſs of a bee or two, when they did ſting, was of no conſequence; for it is ſeldom that more die."

The account of the operations of a hive is now carried completely round the year; but the repetition of the annual revolutions occaſions a ſeries of effects in the comb, which in time produce variations in the life of the hive.

Of the Life of the Bee. The life of the males is aſcertained to be only a month or two, ſince in the winter none are to be found; but that of the queen and labourers cannot poſſibly be determined. Probably it is the young bees which ſwarm; yet ſome young ones may alſo be ſuppoſed to be retained, in order to ſupply accidental loſſes in the ſtock. From analogy we may conclude that a bee's natural life is limitted to a certain number of ſeaſons; and it is probable that no individual inſects of any ſpecies outlives one month others of the ſame ſpecies. Perhaps, after the firſt brood in a ſeaſon, all the laſt winter's bees die, and this firſt brood occupying the hive breeds the firſt ſwarm; and ſo on in ſucceſſion.

The comb may be called the furniture and ſtorehouſe of the bees, which by uſe wear out; for as each maggot depoſites its excrement in the cell, which is not cleared out, and then ſpins itſelf a lining, theſe muſt in time fill up the cell. Bees have been obſerved to breed three times in a year in the ſame cell; and above twenty linings with dried excrement between, have been counted in one cell, which filled it up a quarter or a third. Such a piece of comb, when boiled for the wax, will keep its form, and the ſmall quantity of wax it yields is ſqueezed out at different parts as from a ſponge; whereas a piece of comb that has not been bred in will melt almoſt wholly down. It is the former wax which has the fine yellow tinge. When theſe cells are ſoaked in water ſo as to make the excrement ſwell, the bottom of the laſt lining will ſometimes riſe even with the mouth of the cell, or above it. From this account it appears that the combs of a hive can only laſt a certain number of years; though the bees ſometimes add a little to the mouth of the cells in order to make them laſt longer; but this is not done with pure wax, and the cells are made clumſy by it.

Abridgement of the Meteorological Journal kept at the Apartments of the Royal Society, 1791.

Month	Barometer Inches	Thermometer without	Thermometer within	Prevailing winds		Force
				Quart.		
Greateſt	30.58	53°	58°	1	S. & W.	1 & 2
Leaſt	28,18	31	46	2	Weſt.	1 & 2
Mean	29,56	42,1	52,9	3	S. & W.	2
January.	The firſt quarter of this month was changeable weather, the ſecond and third moſtly cloudy, but fair weather towards the end.			4	W. & N.	1 & 2
Greateſt	30,48	52°.5	57°	1	W. & N W.	2
Leaſt	29,16	30,	48,5	2	W. & S W.	1 & 2
Mean	29,94	41,1	52,5	3	Changeable.	1
February.	The firſt part generally fair, cloudy towards the middle, third and laſt quarters moſtly fair.			4	E. & N.	1 & 2
Greateſt	30,67	55°	61°,5	1	N. & W.	1
Leaſt	28,90	31,5	48	2	W. & N.	2 & 1
Mean	30,20	44,3	55,6	3	W. & N W.	1 & 2
March.	Firſt part clouds and hazy, ſecond and third moſtly fine, the laſt quarter cloudy.			4	N. & E.	1
Greateſt	30,11	64°	64°	1	E. & N E.	2. 1
Leaſt	29,08	41	55,5	2	W. & E.	1
Mean	29,77	51,9	60	3	S W.	2. 1
April.	Firſt quarter fine, ſecond and third fine but cloudy, fourth a litte rain, all cloudy weather.			4	E. & N.	1

Abridgement

Abridgement of the Meteorological Journal kept at the Apartments of the Royal Society, 1791.

Month	Barometer Inches	Thermometer without	Thermometer within	Prevailing winds		Force
Greateſt	30,37	67°,5	61°,5	1	N. & N N E.	1. 2
Leaſt	29,53	39	55	2	S. & W.	1
Mean	30,02	53,1	58,1	3	W.	2
May. Firſt part cloudy and ſome rain, ſecond cloudy but fine, which continued to the end				4	E. & N E.	1
Greateſt	30,22	80	70,5	1	E	1
Leaſt	29,39	47	57	2	N W. & N E.	1. 2
Mean	29,93	61,3	63	3	N E.	2. 1
June. Firſt quarter, fine weather, ſecond fine but cloudy, which continued to the end.				4	W. & S.	1. 2
Greateſt	30,24	78°,5	68°	1	W S W. & W.	1. 2
Leaſt	29,44	32,5	61	2	N E. & W N W.	1. 2
Mean	29,89	62,5	64,5	3	E. & W S W.	1
July. Cloudy and ſome rain at the beginning, ſecond quarter cloudy, but fine, third and laſt changeable and ſome rain.				4	S W.	2
Greateſt	30,52	78,5	72	1	S W. & W.	1.
Leaſt	29,65	50	62	2	E. & N.	1.
Mean	30,06	64,9	67,1	3	N N W. & E.	1.
Auguſt. Firſt quarter cloudy, but fine, much thunder and lightning at the middle, third quarter generally fair, but changeable at the end.				4	W.	2. 1
Greateſt	30,33	77	71,5	1	S W. & W.	2.
Leaſt	29,52	43	58,5	2	E. & N E.	1.
Mean	30,09	59,5	62,5	3	W. & N.	1. 2
September. Firſt part fair, with ſome clouds, ſecond very fine, third cloudy, but fine, and very fine at the laſt.				4	N N E. & E.	1
Greateſt	30,46	62,5	61,5	1	Variable	1
Leaſt	28,89	34	52,5	2	Variable	1
Mean	29,69	48,9	57,8	3	W. & S W	1. 2
October. Firſt quarter changeable, ſecond moſtly fair, third cloudy, laſt moſtly clouds, but ſome fair weather.				4	N E. & E.	1
Greateſt	30,28	52,5	59,5	1	N E. & N.	1
Leaſt	28,76	25	48	2	S. & E.	2. 1
Mean	29,68	43.6	54,5	3	Variable	1. 2
November. Firſt quarter cloudy, ſecond changeable and ſome rain, third more rain, but moſtly fine towards the end.				4	W.	2. 1
Greateſt	30,38	48	56	1	W N W. & W.	2. 1
Leaſt	28,90	21	45	2	Ditto	1
Mean	29,64	36,7	50	3	N E.	1
December. Firſt quarter cloudy, ſecond cloudy, but ſome fair weather, third and laſt ſome fine weather, but moſtly cloudy.				4	Variable	1. 2

Philoſophical

Philoſophical Tranſactions of the Royal Society of London, for the Year 1792. *Part* II.

IX. *On the Converſion of the Subſtance of a Bird into a hard fatty Matter. In a Letter from* THOMAS SNEYD, *Eſq.*

A BIRD, conjectured to be a duck, or young gooſe, was found at the head of a fiſh-pool, where a ſmall brook entered it, lying under water upon the mud. Its ſkin and fleſh were converted into a fatty matter, reſembling ſpermaceti in conſiſtence between the teeth, but void of taſte or ſmell, melting in a ſmall heat, and becoming more ſolid than before on congealing again, and emitting a ſtrong animal ſmell when burning. Mr. Sneyd was induced to ſend the ſpecimen and account, from the analogy to the change of human bodies in the cemetery *des Innocents*, obſerved by M. Fourcroy.

X. *An Account of the remarkable Effects of a Shipwreck upon the Mariners; with Experiments and Obſervations on the Influence of Immerſion in freſh and ſalt Water, hot and cold, on the Powers of the living Body. By* JAMES CURRIE, *of Liverpool, M. D.*

ON December 13, 1790, an American ſhip was caſt away at the mouth of the river Merſey. The crew, fourteen in number, got on part of the wreck, where they paſſed the night. On the next day they were taken up, after remaining twenty-three hours on the wreck, and eleven of the number were found alive, and recovered. Of the three who died were two maſters and the cook. As it appeared extraordinary, that both maſters, hardy vigorous men, ſhould periſh, while the ſurvivors were moſtly perſons long uſed to the climate of Carolina, and one, a negro, particular enquiries were made into the circumſtances. From the relation of the mate, it appeared, that the piece of wreck to which they were laſhed, lay ſloping in ſuch a manner, that the two maſters at the upper part were generally out of the ſea, but frequently waſhed by the ſurge, as well as expoſed to the ſleet and ſnow; the mate himſelf was generally up to the middle in the water, the reſt variouſly immerſed, ſome up to the ſhoulders. One of the maſters died in about four hours, at eight in the evening; the other about three hours after; the cook held out till the forenoon of the next day. The ſurvivors, though immerſed in the ſea, were all of them very thirſty. None were drowſy, nor did ſleep precede death in thoſe who periſhed.

Reflecting on theſe particulars, Dr. Currie had no doubt in imputing the death of the two maſters to their poſition on the wreck, the effects of which would be, expoſing them to be wetted by freſh as well as ſalt water, to the greater cold of the atmoſphere than the ſea, to the chilling action of evaporation in a high wind, and to alternations in the ſurrounding media. In order to aſcertain with preciſion the operation of theſe cauſes, and the power of the body to maintain animal heat in various circumſtances, Dr. Currie reſolved upon ſome experiments on immerſion in freſh and ſalt water.

A healthy man of twenty-eight, with black hair and a ruddy complexion, was the ſubject of four different immerſions in a large veſſel of ſalt water, the particulars of which are here minutely related. The heat of the atmoſphere, and of the water, in theſe was from 42 to 44; the length of time in immerſion, 12, 15, 16, and 30 minutes. In two caſes, when taken out, he was plunged into a warm bath. The ſtate of animal heat was judged of by a thermometer placed under the tongue. The mercury fell rapidly on immerſion, but ſoon began gradually to riſe again, till it became nearly ſtationary at 93½, 95, 96, and 94 degrees. While expoſed naked to the air on coming out of the water, the mercury fell again with rapidity; and even on plunging him into the warm bath, it fell at firſt. In another experiment on the ſame perſon, a continuance in the cold bath at 40 for three quarters of an hour, cauſed the mercury which had got up to 96°, to ſink to 94° again. The ſhiverings produced by cooling in all theſe caſes were moſt ſpeedily removed by the application of a bladder of hot water, to the pit of the ſtomach.

A man of weaker temperament immerſed under ſimilar circumſtances, loſt and regained his heat more ſlowly. On a ſecond trial, after being thirty two minutes in the water, in which time it had riſen from 83° to 92°, it fell again rapidly to 85°, and he was long in recovering his proper temperature, though put inſtantly into the warm bath. The pulſe in all theſe experiments became ſlower, firm, regular and ſmall.

The air and the water being both equally cold, and at 45° or under, the loſs of heat in paſſing from one to the other was found to be regulated in the following way.

1. If, inſtead of being expoſed naked to the wind previous to immerſion in the water, the body was kept warm by a flannel covering, the mercury fell much leſs on the firſt plunge.

2. If, after plunging into the water, the perſon continued in it only a minute or two, a ſubſequent fall of the mercury did not always take place, on his emerging into the air. On the contrary there was ſometimes a riſe on ſuch occaſions in the mercury, eſpecially if the atmoſphere was at reſt.

3. In one inſtance, after continuing in the water fifteen minutes, on riſing into the air in a perfect calm, though during a froſt, there was little or no ſeeming diminution of the heat; while expoſure under ſimilar circumſtances, with a north-eaſt wind blowing ſharply, though the air was many degrees warmer, produced a rapid diminution. The effects of the wind in diminiſhing the human heat are indeed ſtriking, and are not in my opinion explained by the common ſuppoſitions.

4. The loſs of heat by a change of media, depends much on the rapidity of the change, for the plaſtic power of *life* in varying the proceſs of animal heat, ſo as to accommodate it to the external changes, acts for a time with great celerity, though this celerity ſeems to diminiſh with the ſtrength.

5. The influence of the application of cold water to the ſurface of the body, on the heat, is in ſome reſpects regulated by the animal vigour.

The power of the body in preſerving its heat under the impreſſions of cold, and the changes of temperature, and of media, ſeems in ſome meaſure regulated by the condition of the mind. That fear increaſes the influence of cold, and of many other noxious powers, will not be doubted; but the ſtate of the mind to which I allude, is that of *vigorous attention* to other objects.

7. There are particular conditions of the atmoſphere, not perfectly underſtood, that ſeem to have an influence in depriving us more ſpeedily of our animal heat, than others where the cold is greater.

Dr. Currie then gives an account of the immerſion of the ſubject of the firſt experiments into freſh water at 40°. He ſunk ſlowly into the bath, whence the loſs of heat was not ſudden, but after ſome fluctuations it continued to decreaſe during the thirty four minutes that he was in it. His natural heat was not recovered by a warm bath at 106°, and great debility with ſymptoms like the acceſſion of fever came on, which did not leave him till after the next day.

The practical obſervations with which he concludes, are, that when there is only the choice of being wet with ſalt or freſh water, it is ſafeſt to prefer the firſt.---That a conſtant immerſion is better than alternate expoſure to the waſhing of the ſea, and ſhowers of rain or ſnow.---That in high and cold winds without rain or ſnow, the choice of expoſure to them, or immerſion in the ſea, muſt depend upon various circumſtances, perhaps not to be previouſly determined.

In a poſtſcript, he takes notice of a ſuppoſition that may be made, viz. that in the experiments, the water contiguous to the ſkin having become in ſome meaſure heated, the body on emerſion into the air came in fact into a colder medium, which was the cauſe of the loſs of heat then obſerved; and that the ſame would not happen in the ſea, where there is a conſtant undulation. He does not deny that there is ſome foundation for this remark, but is perſuaded that it is not ſufficient to account for the loſs of heat in that inſtance.

XI. *A Meteorological Journal principally relating to Atmoſpherical Electricity; kept at Knightſbridge, from the 9th of May,* 1791. *By Mr.* JOHN READ.

THE apparatus by which Mr. Read collected the atmoſpherical electricity conſiſted of a conductor, being a deal rod twenty feet long, two inches diameter at the lower, and one at the upper end. This was inſulated by reſting on a glaſs column twenty-two inches long, which was fixed in the floor of the garret. The upper extremity of the rod was terminated by ſharp copper wires, two of which were twiſted round the rod down to the lower extremity. From the lower extremity paſſed a ſtrong braſs wire, through a hollow glaſs tube to the room below, terminating at a convenient height from the floor, with a two inch braſs ball, to this there was another braſs wire fixed horizontally and ſuſpending a pith-ball electrometer.

At two inches diſtance from the above-mentioned braſs ball, a bell is ſupported by a ſtrong wire, which paſſing through the wall of the houſe communicates with the moiſt ground adjoining. A braſs ball three tenths of an inch is ſuſpended by a ſilk thread between the braſs ball and bell, and ſerves for a clapper when the electrical charge of the rod is ſufficiently ſtrong.

When Mr. Read found that the inſulation of this apparatus was injured by moiſture in the air, he had recourſe to what he calls his hand exploring rod, "which is about "the length and thickneſs of a common fiſhing rod, with plenty of wire twined round "it from end to end". The method of uſing this laſt is ſimple. Having placed himſelf on an inſulated ſtool, he raiſes the rod into a vertical poſition with one hand, and then touches an electrometer with the other.

As it is impoſſible to abridge the meteorological tables containing the daily reports of the ſtate of the atmoſphere in regard to its electricity, we can only ſubjoin the general reſult as ſtated by himſelf.

A monthly account of ſparks, and of poſitive and negative electricity, as indicated by the pith-ball electrometer, connected with the rod; excepting a few times, in very moiſt weather, in which it was obtained by the hand exploring-rod, with a lighted *torch* to it.

	Times.	Times.	Days.
23 days of May, 1790, and 8 days of May, 1791,	Poſitive 40	Negative 27	Sparks drawn 13
June	Poſitive 45	Negative 22	Sparks drawn 5
July	Poſitive 36	Negative 23	Sparks drawn 8
Auguſt	Poſitive 33	Negative 6	Sparks drawn 3
September	Poſitive 39	Negative 11	Sparks drawn 19
October	Poſitive 37	Negative 7	Sparks drawn 22
November	Poſitive 30	Negative 8	Sparks drawn 11
December	Poſitive 35	Negative 11	Sparks drawn 6
January	Poſitive 28	Negative 8	Sparks drawn 3
February	Poſitive 36	Negative 12	Sparks drawn 6
March	Poſitive 34	Negative 8	Sparks drawn 2
April	Poſitive 30	Negative 14	Sparks drawn 8
	423 times	157 times	106 days

Mr. Read is perfectly ſatisfied from repeated obſervations, and long experience, that the aqueous vapours ſuſpended in the air, are conſtantly electrified, requiring only the aid of a proper collector to render it ſenſible. And therefore it may be ſaid that there is an electrical atmoſphere within our aerial atmoſphere.

During a courſe of moderate weather, the electricity of the atmoſphere is invariably poſitive, and exhibits a flux and reflux, which generally cauſes it to increaſe and decreaſe twice in every twenty-four hours. The moments of its greateſt force are about two or three hours after the riſing, and ſome time before and after the ſetting of the ſun; thoſe when it is weakeſt, are from mid-day to about four o'clock. The periodical electricity of the atmoſphere ſeems to be manifeſtly influenced by *heat* and *cold*. Hence it plainly appears, why we always find warm ſmall rain to be but weakly electrified; when cold rain, which falls in large drops, is the moſt intenſely electrified of any.

Mr. Read here concludes his regular account with a promiſe, that ſhould any remarkable phenomena in future appear during a long courſe of froſty weather, which is the only ſtate of the atmoſphere he has not yet experienced, he will communicate them to the Royal Society.

XII. *Further Obſervations on the Proceſs for converting caſt into malleable Iron: In a Letter from* THOMAS BEDDOES, *M. D.*

THE experiments reported in this paper were inſtituted in order to aſcertain whether the explanation which Dr. Beddoes had given in a former paper of the phenomena which attend that operation, known among the workmen by the term *puddling of iron*, was a juſt one or not.

The points to be aſſertained were, 1. whether any elaſtic fluids are really extricated during the converſion of caſt into malleable iron; and 2. what is their nature; and 3. whether they vary at different periods of the proceſs, as was concluded from the appearances in the furnace. It ſeemed of leſs conſequence to aſcertain their quantity. This however, was not neglected, but ſome very curious circumſtances prevented Dr. Beddoes from attaining it.

The caſt iron was put into glazed and glaſs veſſels, and expoſed to the gradual increaſe of heat of a wind furnace.

From the experiments Dr. Beddoes thinks the inferences he formerly drew fully confirmed. There was in each of the experiments a real extrication of air, varying in its nature at different periods of the operation. In each of them great quantities of inflammable air was obtained, and that before the iron could be ſuppoſed to be red hot; a circumſtance which ſtruck Dr. Beddoes, as rather ſingular. One great difficulty in manufacturing iron appears to be the getting rid of the charcoal. The oxygene readily enough unites with a ſmall portion; but the attraction of the iron on the one hand, and on the other the little diſpoſition of the charcoal, to put on the elaſtic form, in compariſon with many other leſs fixed ſubſtances, together form a very conſiderable obſtacle to the change of charcoal into air.

In the experiments there was in all of them only a partial convertion into malleable iron, namely, at the ſurface, and this very coating was the probable cauſe why the proceſs was checked. In the puddling operation it is of the utmoſt importance to keep the maſs in conſtant agitation, by which means there cannot as Dr. Beddoes expreſſes himſelf, be any parts hide bound.

Theſe obſervations may lead to render the metallurgy of iron leſs difficult, laborious and expenſive. For, 1. if a quantity of oxygène, nearly ſufficient to burn the charcoal, could be chymically combined with the caſt iron, the operation would conſume leſs fuel, and would not require ſo long a time. It may be worth while to conſider if the ores of iron, containing manganeſe, owe any part of their value to this circumſtance. 2. If it could be contrived to apply a ſufficient heat to large quantities of iron in cloſe veſſels, and at the ſame time, to agitate them ſufficiently, the loſs in converſion would not, perhaps, exceed ten in an hundred. 3. The important object of converting Britiſh iron into ſteel, may poſſibly be attained by following up reflections ſuggeſted by the foregoing experiments. When the oxygène has been ſeparated in the form of carbonic acid, there will remain the charcoal and iron, the conſtituent parts of ſteel. Perhaps the materials, at a certain period of the proceſs, may be ſo nearly approaching to ſteel as to be eaſily convertible. The maſs will contain alſo a quantity of ſulphur, on which perhaps the difficulty of making good ſteel from our iron depends. But this difficulty, I am perſuaded, will not be inſuperable.

It may be proper to add, that whenever attention was paid to it, the hepatic ſmell in the extricated air was perfectly diſtinguiſhable.

XIII. *Continuation of a Paper on the Production of Light and Heat from different Bodies.*
By Mr. THOMAS WEDGWOOD.

EXPERIMENT I. In order to diſcover what effect the light of burning fuel has upon incombuſtible bodies, two equal cylinders of ſilver, with poliſhed ſurfaces, half an inch in length, and a quarter of an inch in diameter were fixed into the end of a tube of earthen ware. One of the cylinders was painted over, except the end within the tube, with a thin coat of incombuſtible black colour, to make it abſorb the incident light. The opening at the other end of the tube was made to fit the eye exactly. The end with the pieces of metal was held within a red hot crucible. The reſult was that the end of the blackened cylinder began to ſhine a conſiderable time before the poliſhed one, and was brighter, but after removing the tube from the fire, the poliſhed one retained its light the longeſt. From this it would ſeem that the cylinders had abſorbed ſome light from the crucible, ſince the black one which abſorbs moſt rays became firſt red, and ſhone brighteſt, but this is contradicted by

Experiment II. From this experiment it appeared that a ſtream of air, although not luminous itſelf, after paſſing through a red hot earthen tube, yet cauſed a ſtrip of gold to become ſo, and that it became brighter in proportion, as the tube was rendered hotter. Hence it ſeems as if the greater brightneſs of the blackened cylinder, in the firſt experiment, was owing to its being of a higher temperature, and not to the abſorption of light. Another conſequence that might be drawn from this experiment is, that the *light emitted* is identical with the *heat received*; ſince the gold emitted light from dark air, which was of the temperature of a red heat. Inſtead of offering any hypotheſis for the explanation of the various phenomena of the ſimultaneous *abſorption* and *emiſſion* of light, in a red hot body. Mr. Wedgwood rather chooſes to ſtate a few more obſervations.

Experiment III. A quart of oil took exactly the ſame time to acquire an equal quantity of heat, whether the flaſk in which it was contained, was blackened or not. Hence it appears that black matter has no particular attraction to light in a quieſcent ſtate.

Experiment IV. In this experiment three equal cylinders of earthen ware, one blackened, another gilt, all but the ends within the tube, and the third glazed, all became *red* at the *ſame time*, and they alſo diſappeared together.

Experiment V. Equal pieces of gold, ſilver, copper, and iron, became red in the order in which they are ſet down, and when made equally red, the temperature diſappeared in the ſame order. An earthen ware cylinder diſappeared ſooner than any of them, owing to the internal parts not communicating the heat quick enough to the ſurface.

Several other experiments upon blackened earthen cylinders on glaſs and glazed ware, and on ſome metals follow, but which as they do not lead to any one general concluſion on the principal ſubjects, we find impoſſible to abridge.

The paper then concludes with ſome miſcellaneous obſervations.

" Red hot bodies though ignited by *white* light, give out only the red rays." Mr. Wedgwood ſuppoſes the more *refrangible* rays, from their greater attraction to matter, may be circulating as heat, whilſt the red ones having a leſs attraction, eaſily eſcape.

The flaſh of gun-powder is a pure white light: but as it only appears red through a thin glazed earthen ware tube, he ſuppoſes a certain portion of the bright rays to combine with the matter of the tube.

The ſudden ignition of bodies by attrition, he conſiders as owing to compreſſion, and conſequent diminution of the capacity for heat.

XIV. *A Narrative of the Earthquake felt in Lincolnſhire, and the neighbouring Counties, on the 25th of February,* 1792. *By* EDMUND TURNOR, *Eſq. F. R. S.*

THIS conſiſts of various ſhort notices of a ſlight ſhock of an earthquake felt in the midland and north-eaſtern parts of England, taking a direction from weſt to eaſt. The weather was calm and cloſe, at the concluſion of a froſt.

XV. *Experiments made with the View of decompounding Fixed Air, or Carbonic Acid.*

By GEORGE PEARSON, *M. D. F. R. S.*

THAT aëriform ſubſtance firſt deſcribed by Dr. Black in the *Phyſical* and *Literary Eſſay* of Edinburgh, under the appellation of fixed air, having afterwards been proved by Meſſrs. Bewley, and Bergman, to be an acid, its compoſition, was of courſe, conſidered in the new ſyſtem of chemiſtry, to be ſimilar to that of other acids, that is, as conſiſting of a peculiar baſis, and reſpirable air.

The fact was afterwards eſtabliſhed by Mr. Lavoiſier, an account of whoſe experiment was publiſhed in the Memoirs of the Academy of Science for 1791, and in his *Traité Elémentaire.* By this experiment he proved that charcoal of wood combined with pure air formed fixed air.

What Mr. Lavoiſier did by ſyntheſis, Mr. Tennant, F. R. S. had the honour of doing by analyſis, an account of which is publiſhed in the *Philoſophical Tranſactions* for 1791. By this experiment it appears that charcoal and phoſphoric acid were produced by applying phoſphorus to red hot marble, from which Mr. Tennant inferred, that the carbonic acid of the marble was decompoſed. Dr. Pearſon, however, cannot agree with him, that this decompoſition is owing to the united powers of affinity between phoſphorus and the reſpirable air of the carbonnic acid in the calcareous earth, and between the phoſphoric acid, thus compoſed, and the quick lime of the calcareous earth.

" For the well known fact, that phoſphorus cannot be produced from bone-aſhes by the application of charcoal and heat, I think, only proves that the powers of affinity between reſpirable air and phoſphorus, together with the affinity between the compound formed by their union (namely, phoſphoric acid,) and quick-lime, are *not inferior* to the joint affinities between the reſpirable air, in the phoſphoric acid, and charcoal, and between the compound of reſpirable air and charcoal (namely, carbonic acid) and quick lime. Hence, from the principle referred to, it could not be concluded, that carbonic acid, combined with quick-lime, would be decompounded by phoſphorus attracting its reſpirable air, and the phoſphoric acid, thus formed, attracting the quick-lime."

Since phoſphorated mineral alkali does not yield charcoal by expoſure to heat, unleſs plumbum corneum be added, we cannot infer that the carbonic acid in mild mineral alkali will be decompoſed by phoſphorus, becauſe as in the caſe above, the joint affinities between reſpirable air and phoſphorous, and between phoſphoric acid and mineral alkali, are by this fact ſhewn to be not inferior to the conjoined affinities between charcoal and reſpirable air, and between carbonic acid and that alkali. The ſame thing can only be ſaid when charcoal is applied to phoſporated vegetable alkali. The queſtion alſo whether carbonic acid united to barytes and to magneſia can be decompounded by phoſphorus, remains to be determined.

The following experiments it is preſumed will throw light not only on theſe points of affinity, but alſo ſhew, in ſeveral inſtances, that carbonic acid is decompounded and affords reſpirable air and charcoal.

Experiments with phoſphorus, applied to mild foſſil alkali.

The pureſt foſſil alkali was employed from which Dr. Pearſon expelled $\frac{67}{100}$ of its weight of water, but no carbonic acid. Eight hundred grains of this alkali and two hundred grains of phoſphorus were introduced into a thick white glaſs tube; the tube was then bent, and that part containing the phoſphorus expoſed to a red heat twenty minutes. Phoſphorus was ſublimed to the upper part of the tube, ſome drops of water came over, and about a two ounce meaſure of phlogiſticated air. After the whole was cool, 428 grains of a black coheſing alkaline maſs, and above it 358 grains of a grey and white ſubſtance. Some glaſs being melted the total weight could not be accurately aſcertained.

The 428 grains of black matter yielded 25 ounce meaſures of carbonic acid on being diſſolved in boiling concentrated acetous acid. This ſolution was filtered, and the reſidue laxiviated and dried. This was found to weigh 34,4 grains, and proved to be charcoal.

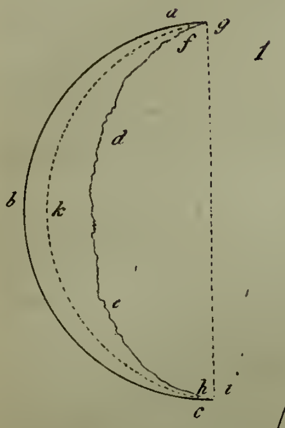
The filtered ſolution was then evaporated to one pint, and ſhewed ſigns of acidity. To it was added muriated lime. The dried precipitate weighed 130 grains, and was found to be phoſphoric acid combined with lime. The grey matter, containing bits of melted glaſs, weighing 358 grains, being diſſolved in concentrated acetous acid, afforded 41 ounce meaſures of carbonic acid, and a reſidue on the filter of 44 grains.

To ſatisfy himſelf that carbonic acid had been deſtroyed, he ſeparated by concentrated acetous acid, from 400 grains of mild alkali, 104 ounce meaſures of carbonic acid. Some other experiments proved that carbonic acid had not been combined or eſcaped in the experiment, but had been deſtroyed. From the whole, therefore, it may be fairly deduced, that the reſpirable air and charcoal were derived from the carbonic acid, ſince no other ſource could be diſcovered; and that the carbonic acid is decompounded by the ſuperior affinities between phoſphorus and reſpirable air, and phoſphoric acid and alkali, to thoſe between reſpirable air and charcoal, and carbonic acid and alkali.

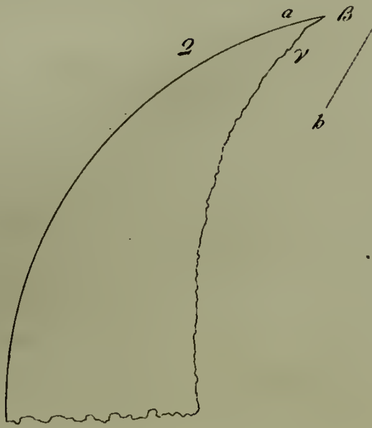
XVI. *Obſervations on the Atmoſpheres of Venus and the Moon, their reſpective Denſities, perpendicular Heights, and the Twilight occaſioned by them. By* JOHN JEROME SCHROETER, *Eſq. of Lilienthal, in the Dutchy of Bremen.*

TWELVE years ago Mr. Schroeter was convinced, by the gradual diminution of light on Venus, that it had an atmoſphere of no ſmall extent. His obſervations were then made with a three-feet achromatic teleſcope, and have been ſince frequently repeated with an Herſchellean four and ſeven feet reflector.

Plate VII. Fig. 1, No. 1, repreſents Venus. The light appears ſtrongeſt at the outward limb *a b c*, and decreaſes gradually to the interior edge, where becoming dim it generally loſes itſelf in a faint bluiſh grey, forming an indefinitely ragged margin, *g f d e h* ſcarce diſcernible with the beſt teleſcopes. This diminution of



1



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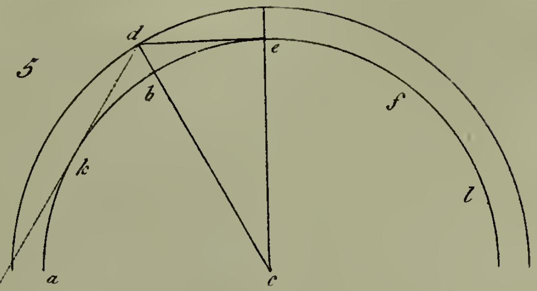

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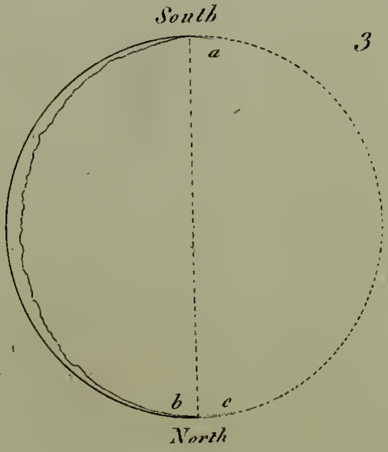

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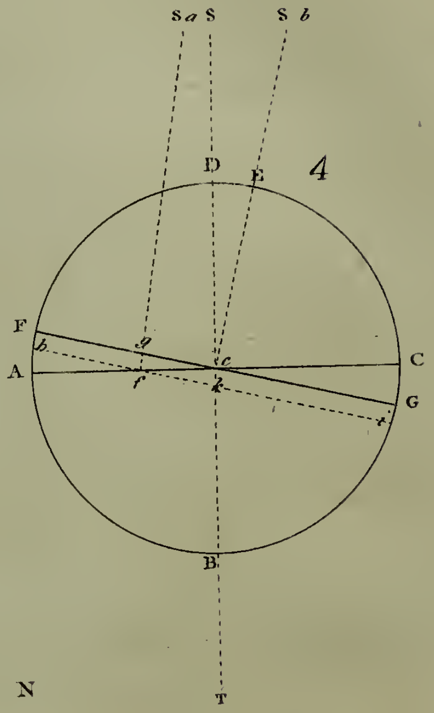
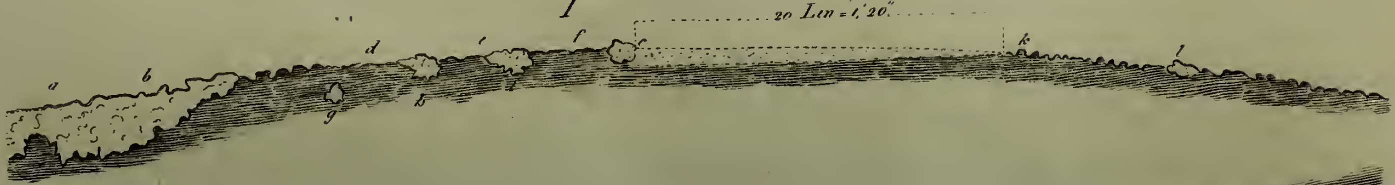
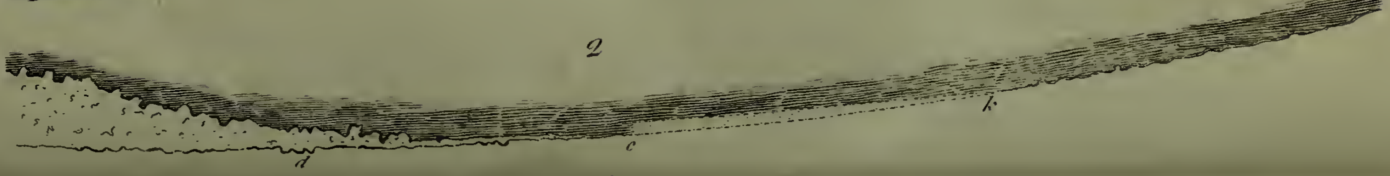


4

ATMOSPHERE of the MOON



1



2

of light is much more ſenſible in the middle *d*, *e*, than at the cuſps, where mountains of immenſe height are ſuppoſed to have a peculiar effect.

Let $\alpha\ \beta\ \gamma$, No. 2, be ſhadowed from α to β, the cuſp, though it may be blunted from α to γ, will, as the whole breadth does not exceed $\frac{1}{4}$ of a ſecond, appear ſharp. We do not ſee the faintly illuminated part $\alpha\ \beta$, nor the real luminous edge $\beta\ \gamma$, but its bright part only $\alpha\ \gamma$; in other parts the mountains may occaſion a ragged appearance, but cannot materially affect the very faint light of the whole.

On the 20th of November, 1791, Mr. Schroeter uſed a reflector with a power 161, and ſaw the light on the inner margin dwindle away, and appearing for the breadth of about 1 or $1\frac{1}{2}$ ſeconds almoſt as grey as the aſh-coloured ſpots in the moon, and with high magnifying powers he has obſerved it frequently, but eſpecially in the day time, loſing itſelf in the colour of the ſky. But his moſt important obſervations were made between the 9th and 16th of March, 1790. At that time the ſky was unuſually ſerene; Venus was in Aries at 7° and 8° N. dec. and notwithſtanding the approaching inferior conjunction on the 18th, was obſerved on the 16th.

On the 9th, from ſun-ſet to 6*h*. $45'$, he ſaw Venus with a ſeven-feet reflector, power 74,95, and 161, very diſtinctly, and uncommonly ſplendid. The ſouthern cuſp diſappeared as repreſented in No. 3, inflected like a hook beyond the luminous ſemicircle into the dark hemiſphere. The northern cuſp was terminated in the ſame tapering manner, but did not extend into the dark hemiſphere. From its point a ſtreak of glimmering bluiſh light proceeded from *b* to *c*, which, like the luminous line then ſeen on Saturn, ſeemed to twinkle in various detached parts, was very faint compared with the light at the point of the cuſp, and its colour verged to that of a pale greyiſh hue. The limb of the planet, at this ſmall part of the dark half, appeared as pale as the dark limb of the moon three days before and after the new moon, and its light vaniſhed into a pale bluiſh tint, like that of the luminous hemiſphere, towards the extremities of the cuſps. This is accurately delineated in No. 3, from the drawing of an artiſt, who obſerved the phænomenon about an hour with the writer. The apparent diameter of Venus was $59''$, the greateſt breadth of the illuminated part did not exceed $2{,}6''$.

On the following evening the four-feet reflector, with powers 134 and 70, was uſed from 6*h*. to 6*h*. $40'$. The ſouthern cuſp had its luminous prolongation, but not quite ſo diſtinct as before, and each cuſp had a faint tapering prolongation of a bluiſh grey caſt, extending into the dark hemiſphere, ſo that the enlightened limb was conſiderably more than a ſemicircle.

On the next evening Mr. Schroeter had an opportunity of accompliſhing his deſire, to aſcertain whether the projection of the glimmering ſtrip of pale light belonged only to the northern cuſp. At ſix o'clock he uſed the ſeven-feet reflector, powers 74 and 95, and obſerved that this light extended ſeveral degrees along the limb of the dark hemiſphere, but there was no appearance of a pale bluiſh prolongation at the ſouthern cuſp. He then aſcertained with the projection machine,

1. That the faint ſtreak at the northern cuſp extended at leaſt $8''$ of a degree along the limb of the dark hemiſphere.

2. That the prolongation of the ſouthern cuſp meaſured full $8''$, its hooked form appearing very diſtinctly.

3. That the apparent diameter of Venus was between $59''$ and $60''$.

Some obſervations made ſeveral mornings after the conjunction, confirmed what has been above mentioned, from whence the following inferences are drawn.

1. The pale aſh-coloured light *b c*, No. 3, muſt proceed immediately from the ſun, or it is crepuſcular. It cannot be light proceeding from the ſun, for it does not appear in ſingle detached points, but is a continued ſtreak of light to the extent of 15° 19′ of the planet's circumference.

2. Were it light from the illuminated ſummits of mountains it would not be ſo regularly connected.

3. There is as great a difference between this light and that ſeen immediately on the cuſp, as between the ſolar light on the moon and that reflected on it from the earth, and had this light been an emanation from the ſun there would have been a gradual diminution of it, which was not the caſe.

That it is a real twilight will appear from the relative appearances of the cuſps. On the 9th and 12th of March, 1790, when the ſouthern cuſp extended in a hooked direction into the dark hemiſphere, the pale blue light appeared only at the point of the northern cuſp, and proceeded in a ſpherical curve into the dark part. On the 10th of March, when the ſouthern cuſp did not proceed ſo far, the pale ſtreak was perceived at both points, but more ſenſibly at the northern. The bright prolongation of the ſouthern cuſp on the 10th and 12th of March, muſt be aſcribed to the ſolar light on a ridge of mountains, whence it would not be ſtrictly ſpherical. When the bright prolongation was not conſiderable, twilight had its due effect, and the true ſpherical arc of the dark limb appeared faintly illuminated.

To find the extent of the twilight, let F D G B, No. 4, repreſent Venus, S the ſun, T the earth, according to their ſituations on the 12th of March, 1790. F G perpendicular to S *c*, divides the light from the dark part, G *c* C is the luminous part ſeen from the earth, and *c* its cuſp. Aſſume *h i* parallel to F G, as the boundary of twilight, and let *g f* parallel to *b* E *c*, the central ray from the ſun, repreſent the prolongation into the dark hemiſphere, *f c* the ſtreak of light projecting into the dark hemiſphere = 8″ of a great circle, or 15° 19′ of the planet's circumference. The angle $g\,c\,f =$ D *c* E, which being the ſupplement of the angle S *c* T is given. On this day it was by calculation, at ſix in the evening, 17°49′45″

$$\begin{array}{lcl} \text{by Sp. Trig. S.} fg & = & \text{S.} fc \times \text{S.} fcg \\ \text{Log. S.} fc & = & 9{,}4218566 \\ + \text{Log. S.} fcg & = & 9{,}4859768 \\ \hline \text{Log. S.} fg & = & 8{,}9078334 \\ \therefore \text{Arc } fg & = & 4^\circ 38' 30'' \end{array}$$

Suppoſing the ſemidiameter of Venus equal to 834900 geographical miles, the extent of the twilight *f g* amounts to 67 miles, and this twilight may be compared to that on our globe, when its border paſſes through the zenith, and the ſun is 6° 23′½ below our horizon.*

The projection of the twilight *f c*, amounted to 8″, whence S. *f c* × S. 17°49′45″, gives for the true extent of the twilight *f c* only 2,″45 of a degree.

Hence it is evident why, ſince the extent is ſo ſmall, the twilight appears only at the cuſps, and only a few days before and after the conjunction; as alſo, ſince ſuch favourable circumſtances were requiſite to diſcover this phænomenon, why it was not noticed before, and may not be obſerved again for ſome time.

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* Lambert's Photom. § 998, Berl. Ephe. 1776.

As the keeneſt eye, aided by the beſt teleſcopes, cannot diſtinguiſh the final termination of twilight, and it has been proved to extend 4° 38′ 30″ into the dark hemiſphere, it is not improbable that its whole extent is equal to that on the earth, or 18°, and we may apply the ſame principles to diſcover the height of the atmoſphere capable of reflecting the ſolar light, to be viſible to us, as are uſed for the twilight on the earth.

Let $k\,b\,e\,l$, No. 5, be the ſurface of Venus, k be $= 4^\circ 38' 30''$, $b\,a$ the height of the denſer part of the atmoſphere, $b\,d$ the firſt ray of the ſun reflected to e, $c\,e = 834$ geogr. miles, $e\,c\,d = 2^\circ 19' 15''$. In the right angled $\triangle\, c\,d : c\,e :: \text{Rad} : \cos.\, d\,c\,e.$ $\therefore$ $c\,d$ is given, ſubſtract from it $c\,e$, and the remainder $d\,b = 2526$ toiſes, or 15156 Paris feet = the height of the atmoſphere.

The computation depending only on a ſingle reflection of the ſolar rays is evidently conjectural; but it may afford the means of diſcovering the height and denſity of the atmoſphere with greater preciſion. If it is allowed that this atmoſphere is denſe enough at the height of 15000 toiſes to reflect ſo clear a light on a zone extending 67 geographical miles into the dark hemiſphere, it muſt riſe far above the higheſt mountains, and be more opake than that of the moon, and this denſity is a ſufficient reaſon for our not being able to diſcover ſuch ſuperficial ſhades as are to be ſeen on the other planets.

On the Atmoſphere of the Moon.

Mr. Schroeter refers to his ſelenotopographic fragments for proofs of the exiſtence of a lunar atmoſphere producing a faint twilight, which are confirmed by a ſingle obſervation made on Feb. 24, under the moſt favourable circumſtances.

At 5*h*. 40′ in the evening, 2*d*. 12*h*. after the new moon, the weſtern border of Mare Criſium being 1′ 20″ from the weſtern limb, he was attentive in obſerving with the ſeven-feet reflector, power 74, whether the dark hemiſphere would emerge out of the twilight at many parts at once, or at firſt only at the cuſps. Theſe cuſps diſtinctly tapering in a ſharp, faint, and ſcarcely interrupted prolongation, the fartheſt extremity being faintly illuminated by the ſolar rays, appeared before any part of the dark atmoſphere was ſeen; ſoon after the border of the dark atmoſphere began to appear, firſt at the cuſps, where it diſplayed a margin about a minute in breadth of a very pale grey light, as faint as the twilight on the dark hemiſphere of Venus, which, fading gradually toward the eaſt, left the border on that ſide undefined, and loſt itſelf in the colour of the ſky. This light was of the ſame extent at both cuſps, and faded away in the ſame proportion. No part of the dark hemiſphere was perceptible, except the ſummit of Leibnitz ſtrongly illuminated by the ſolar rays, and eight minutes elapſed before the remainder of the limb became viſible.

No. 1 and 2, are intended to convey an idea of this obſervation. The ſouthern cuſp, No. 1, extended from a to c, being at c terminated by a mountain. This luminous curve was throughout, except where the glare of the ſolar rays ſpread ſome degree of light, bordered with the pale aſh colour of the dark hemiſphere, out of which roſe the mountains g, h, i, c, and l, or Leibnitz two minutes from c, illuminated by the ſun. The twilight extended from c to k, being broadeſt and brighteſt at c, and gradually decreaſing to k, where it loſt itſelf in the faint glimmering of the terreſtrial light. The appearances were the ſame at the northern cuſp.

Leibnitz was illuminated by the ſolar, and Ariſtarchus by the terreſtrial rays. Leibnitz, compared with the thin luminous arc $d\,e\,f$, and the mountains g, h, i, c, had a very pale fading light, which was however brighter than that of Ariſtarchus; but the light of the latter was much brighter than the twilight from c to k.

This twilight extended to about two-thirds of the diſtance between c and l, which being equal to 30 lines or 2′, the length of twilight may be eſteemed = 20 lines or 1′ 20″. Its greateſt breadth eaſily aſcertained was equal to two-thirds of a line, or 2″. No veſtige of crepuſcular light was ſeen at any other part.

This pyramidal light could not be the effect of the ſolar light, without admitting the denſity of the lunar atmoſphere ſuperior to that of ours. It was ſo faint, that it diſappeared at 7*h*. 20′, whilſt Ariſtarchus was very diſtinguiſhable. Beſides, had it proceeded directly from the ſun, it would not have broken off ſo ſuddenly at both the cuſps. Hence therefore this appearance, like the ſimilar one in Venus, can be aſcribed only to the reflection of the ſolar rays in the moon's atmoſphere.

The ſame computation may be uſed for the lunar atmoſphere as for that of Venus, No. 4, now repreſenting the moon.

The diſtance from c to k, No. 6, 7, = 20 lines = 1′20″, and app. diam. of the moon = 31′ 18″ ∴ the twilight extended over an arc = 4°53′ 23″, which ſuppoſing the moon's real diameter to be 465 geogr. miles = $19\frac{3}{4}$ miles.

No. 4, $f\,c\,g = \mathrm{S}\,c\,\mathrm{E}$ = by calculation 31°47′7″.

$$\begin{aligned} \mathrm{S}.fc \times \mathrm{S}.fcg &= \mathrm{R} \times \mathrm{S}.fg \\ \mathrm{Log.\ S}.fc &= 8{,}9306436 \\ +\,\mathrm{Log.\ S}.fcg &= 9{,}7215942 \\ \hline \therefore \mathrm{Log.\ S}.fg &= 8{,}6522378 \\ \therefore fg &= 2^\circ 34' 25'' \end{aligned}$$

= breadth of the lunar twilight from the border to where it loſes itſelf in light reflected from the earth = 10,5 lines = $10\frac{1}{2}$ geogr. miles.

Hence is found alſo the perpendicular height of the denſe part $b\,d$, No. 5, $d\,c\,e = 1^\circ 17' 6''$, rad. $b\,c$ = 234 geogr. miles = 891914 toiſes.

$$\begin{aligned} \mathrm{Log.}\ ce &= 5{,}9503210 \\ -\,\mathrm{Log.\ cos.}\ 1^\circ 17' 6'' &= 9{,}9998908 \\ \hline &\ 5{,}9504302 \\ cd &= 892140 \\ bc &= 891914 \\ \hline \therefore cd - bc &= 226 \text{ toiſes, or 1356 Paris feet.} \end{aligned}$$

Mr. Schroeter was well aware that the twilight muſt be pyramidal, but it did not occur to him at firſt, why its greateſt breadth $c\,k$ ſhould be only one half or at moſt two thirds of a line. But the difficulty was ſoon removed, $k\,c$ = 10,5 lines, or an arc of 2° 34′ 12″, which not lying along the edge of the limb, but nearly at right angles, muſt be diminiſhed to give its true length on the principles of orthographic projection, from which it is found by calculation = 0,5 lines, or full 2″ the breadth given by obſervation.

That this twilight does not appear four days after the new moon will not ſurprize any one, who conſiders, that the ſpots Manilius and Menelaus, the one of 24 the other between 14 and 16 ſeconds diameter, though they appear on the third day, with a degree of light ſurpaſſing that of the twilight, vaniſh on account of the increaſing glare of the moon's light, by the fourth day after the new moon. And as the denſe part of the atmoſphere capable of reflecting the crepuſcular light is only 1356 Paris feet in height, it is evident that ridges of mountains at or near the border, may partially or wholly prevent this light from being obſerved at the cuſps.

Theſe things being granted, we may infer, that the rarer parts of the atmoſphere extend above the higheſt mountains of the moon. The conſiderable denſity alſo of the lower part accounts for the diminution of light at the cuſps, and on Leibnitz and Doerfel, when illuminated in the dark hemiſphere, and for frequent changes obſerved on the moon's ſurface.

The atmoſphere of the moon is ſtill much rarer than ours. For our twilight when the ſun is 4° below the horizon ſurpaſſes the light reflected by the earth on the moon, 12½ days before and after the new moon. But allowing an equal degree of intenſity, our atmoſphere reflecting as ſtrong a light over 4° as that of the moon does over 2° 34′ on their reſpective circumferences, muſt be at leaſt eight times higher than that of the moon, and it is in the ſame manner deduced, that the atmoſphere of Venus is much brighter than that of the moon.

From the rareneſs of this atmoſphere it follows, that the inflection of the ſolar rays touching the moon cannot be conſiderable, and Mr. Sejour's computation making it amount to $4'' \frac{1}{2}$ is confirmed.[*]

The brighteſt twilight will on calculation be found to laſt, at leaſt at the nodes, 5*h*. 3′ and will be longer in other parts of the orbit according to the ſituation of the nodes.

The occultations of ſtars confirm the above remarks. Mr. Schroeter obſerved a teleſcopic ſtar of about the 10th or 12th magnitude on 25th Feb. 6*h*. P. M. within a few ſeconds of the moon's edge. He counted 20″ before the occultation, and $18''\frac{1}{2}$ without the leaſt diminution of the ſtar's light, during the remaining $1''\frac{1}{2}$ it gradually faded till it vaniſhed in an inſtant. Now as the denſer part of the atmoſphere does not meaſure above 2° 34′, the greateſt extent cannot exceed 5° 8′, or be capable of inflecting the ſolar rays at a greater height than 5376 feet = an arc of 0,94″ of a degree, and as the moon deſcribes 1″ in 2″ of time, the fading of a ſtar cannot laſt quite 2″ of time.[†]

Supplement to the foregoing obſervations on the atmoſphere of the moon.

On the 7th of April, 1792, Mr. Schroeter, with his ſeven-feet reflector, power 74, obſerved an occultation of Jupiter by the moon, two of the ſatellites were to the weſtward of Jupiter, the ſecond about one, and the firſt near two diameters diſtant from its limb, the two others to the eaſt being diſtant, the third about ſeven, and the fourth eight diameters.

Immerſions,

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[*] See De la Lande's Aſtronomy, § 1992---1994.

[†] This does not agree with Colonel Pearſe's obſervation, February 13, 1777. See p. 14.

Immerſions.

The firſt ſatellite diſappeared behind the ſharp bright limb of the moon about 10*h*. 43′12″ becoming indiſtinct at the limb.

The ſecond diſappeared without becoming indiſtinct exactly at 10*h*. 45′ 19″.

The weſtern limb of Jupiter came in contact diſtinctly at 10*h*. 46′ 32″,5,

The eaſtern limb diſappeared diſtinctly at 10*h*. 48′ 20″,5.

The third ſatellite having been 1″ or 2″ indiſtinct diſappeared at 10*h*. 58′ 57″,5.

The third ſatellite undiſcernible near the limb, vaniſhed about 11*h*. 2′ 16″.

Emerſions.

The weſtern limb of Jupiter emerged diſtinctly at 11*h*. 43′ 54″.

The eaſtern limb as diſtinctly at 11*h*. 45′ 39″,5.

The emerſion of the third ſatellite was not obſerved.

That of the fourth was diſtinct at 11*h*. 59′ 1″.

When Jupiter was half or more than half covered by the moon, the belts and other parts were as diſtinct as when at ſome diſtance from the moon, and this is not to be wondered at, on conſidering the ſmall extent of the atmoſphere, the approach of ſo large a body as Jupiter, and the ſmall magnifying power uſed in the obſervation.

On the 28th of March, five days after the new moon, Mr. Schroeter obſerved an occultation of a very diſtinct teleſcopic ſtar, which vaniſhed in an inſtant without the leaſt diminution of light.*

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* The Herſchellean teleſcope uſed in the preceding obſervations is an improvement on the Newtonian. The rays reflected by the concave ſpeculum are not intercepted as in the Newtonian, by the plain mirror, but paſs into the eye tube, placed in the ſide of the large tube nearly parallel to the axis, ſo that the obſerver turns his back to the object and looks directly at the object ſpeculum. As there is no loſs of light by a ſecond reflection, ſuppoſing the dimenſions of the magnifying powers the ſame, the brightneſs of the image in the Herſchellean will be nearly twice as great as it is in the Newtonian teleſcope. On the firſt application of the Herſchellean teleſcope to the planet, Herſchell the inventor diſcovered its ſatellites.

XVII. *Ab-*

XVII. *Abſtract of a Regiſter of the Barometer, Thermometer, and Rain, at Lyndon, in Rutland.* By THOMAS BARKER, *Eſq; with the Rain in Surrey and Hampſhire, for the Year* 1791.

		Barometer.			Thermometer.						Rain.			
					In the Houſe.			Abroad.			Lyndon.	South Lambeth.	Selbourn.	Fyfield.
		Higheſt.	Loweſt.	Mean.	High.	Low.	Mean	High.	Low.	Mean				
		Inches.	Inches.	Inchcs.	°	°	°	°	°	°	Inches.	Inches.	Inches.	Inchcs.
Jan.	Morn.	29,92	27,92	29,01	44½	36	40½				2,410	2,91	6,73	3,82
	Aftern				46	36	41							
Feb.	Morn.	96	28,66	43	48	3[illegible]½	41½	48½	28½	37	1,268	2,29	4,64	1,81
	Aftern				48	38	42½	51	35	42½				
Mar.	Morn.	30,11	41	67	51	38	45	49½	28	39	0,813	92	1,59	0,90
	Aftern				53	40	46	56	37	47½				
Apr.	Morn.	29,65	62	30	56	46	50½	53½	39½	45	1,934	1,57	1,13	0,99½
	Aftern				58	46½	52	65	45½	56				
May	Morn.	91	29,01	54	57	45	51	53½	38	47	1,140	76	1,33	0,59½
	Aftern				59½	46	53	68	43½	57				
June	Morn.	78	06	49	67½	52	59	64	43	53½	0,921	60	0,91	0,71
	Aftern				70½	53	61	80	52	66				
July	Morn.	80	00	40	66	56½	60	63½	51½	56	4,033	2,67	5,56	3,45½
	Aftern				69	58	61½	79½	56	67				
Aug.	Morn.	30,06	02	59	69	55½	62	67	49	58	2,907	1,26	1,73	1,92
	Aftern				71	57	63½	80½	58	68				
Sep.	Morn.	29,88	01	64	65½	53	58½	64	43	53	0,596	27	1,73	0,77
	Aftern				69	54	60	72	55	63				
Oct.	Morn.	30,00	28,33	22	57½	44	50½	57	30½	43½	3,319	2,33	6,49	3,06½
	Aftern				58½	45	51½	65	41½	52				
Nov.	Morn.	29,80	28,30	17	48½	38½	44	50	35	40	4,231	3,44	8,16	3,86½
	Aftern				49	41	45	51½	36	44½				
Dec.	Morn.	88	50	14	44	29½	36	41	16	31	1,150	1,44	4,93	2,15
	Aftern				44	29	37	46½	25½	35				
											24.722	20.46	44.93	24.05½

Of milking Ewes. "We find in the Greek and Roman writers, and alſo by ſome paſſages in the Bible, that it was the cuſtom, in former times, to milk ewes as well as cows; and, perhaps, it may better be done in thoſe hotter climates than in England; yet I find it ſpoken of as having been practiſed in this iſland many years ago. Tuſſer, who lived in Suffolk, and was a young man in Edward the VIth's time (ſee his life at the end of his work), mentions it as uſed in his time.

He ſays, five ewes will give as much milk as one cow; and they uſed the milk ſometimes mixed with cow's milk, and ſometimes ſeparate. Ewes ſhould not be milked too freely, unleſs they have good paſture; but with prudent management, a profit may be made of milking them; and he is for doing it from May-day till Lammas, but not longer, for fear of killing them. As he ſeems to have been bred a ſinging boy at Wallingford, the *requiem æternam* probably refers to ſome hymn he there ſang.

But, I ſuppoſe, this method of milking ewes was not found to anſwer upon the whole, for it is left off in England now. I never was in any part of it where it is practiſed at preſent; though by the increaſe of incloſure, and ſowing of ſeeds, we have better paſture for our ewes than Tuſſer had. I think it muſt be very bad for the lambs to be weaned at May-day, which is often before the graſs is fully come, though his lambs were earlier than ours; for it appears in his January's Huſbandry, that the ewes were about lambing then, whereas ours do not come till Lady-day. We do not wean our cade-lambs till June, in the height of ſummer, and then they are not ſo good as thoſe which go with ewes till the latter end of Auguſt.

XVIII. *Obſervations on the remarkable Failure of Haddocks, on the Coaſt of Northumberland, Durham, and Yorkſhire. By the Rev.* Cooper Abbs.

FOR the three laſt ſeaſons there has been an almoſt total failure of Haddocks on the coaſts, where for about three months, beginning at Martinmas, they uſed to be annually caught in vaſt quantities, to the great benefit of the fiſhermen and of the country. Various conjectures have been formed reſpecting the cauſe of this failure, but the only circumſtance yet diſcovered adequate to the effect, is contained in the following narrative in Mr. Abbs's ſecond letter, drawn up from perſonal inquiry of two reputable maſters of ſhips at North-Shields. “ That in the latter end of July, 1789, on the light paſſage to Archangel, after doubling the North Cape (where they joined eight or ten ſail of large ſhips from various ports and nations), and reduced their latitude from 69 to 68, between Fiſher's Iſland and Sweetnoſe, for about thirty leagues eaſt and ſouth, they, to their great ſurpriſe, for the ſpace of three days, in which they had variable winds, or light airs, fell in with immenſe quantities of haddocks and coalfiſh, and no others whatever (the laſt is an ordinary fiſh, and perhaps its name may be local here, and unknovn to you, but I confeſs I do not know any other name it has), lying on the ſurface of the ocean, and ſufficient, from the view they had of them for the three days, to have loaded all the ſhips then in company. That they found them for the ſpace of between twenty and thirty leagues in length, and in breadth, to the eaſt, from three to five leagues, as the ſhips ſtood off and on; but how much farther to the eaſt, and a few other points, they might extend, theſe perſons cannot pretend to ſay, ſuch points being out of their courſe for the ports they were deſtined to. That moſt of the fiſh were dead, though ſome were alive, as appeared by a ſlight motion of the tail, but in a very weak, feeble ſtate, and unable to ſink in the water.

In the above particulars Meſſrs. Stoker and Armſtrong perfectly agree, as to the truth of the fact. The latter, through cautious timidity, prevented his crew from taking up any of the fiſh; but the former took on board many, both dead and in a dying ſtate, of which he firſt ate, and then ſuffered his men to do the ſame: and at Archangel gave the remainder to the cuſtomhouſe officers, without any perſon receiving the leaſt injury. Mr. Stoker having, previous to eating the fiſh, tried the uſual experiment at ſea, of putting ſilver into the freſh water wherein the fiſh were boiled, the ſilver was not at all diſcoloured.

Talking with Mr. Stoker, in his parlour, I aſked him how many fiſh he could take up in that or any other given ſpace. He anſwered, that in various places the fiſh lay ſo

Facing pa. 169

Plate. VIII.

Fig. 1

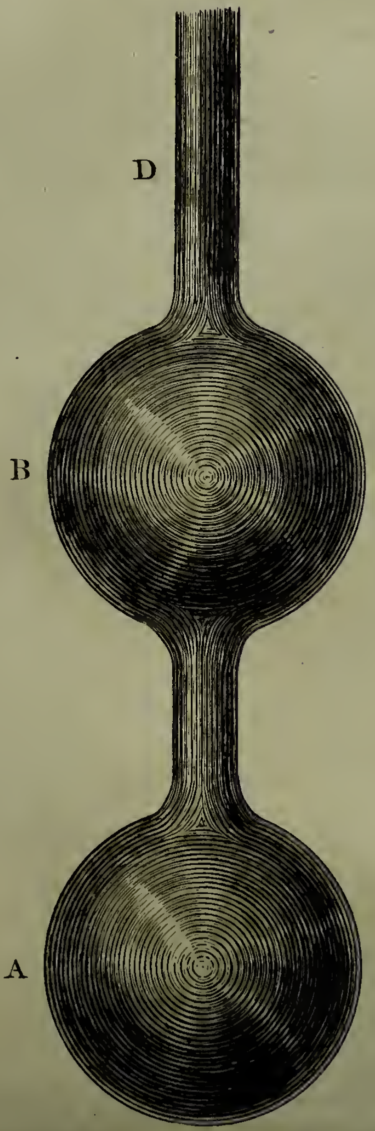
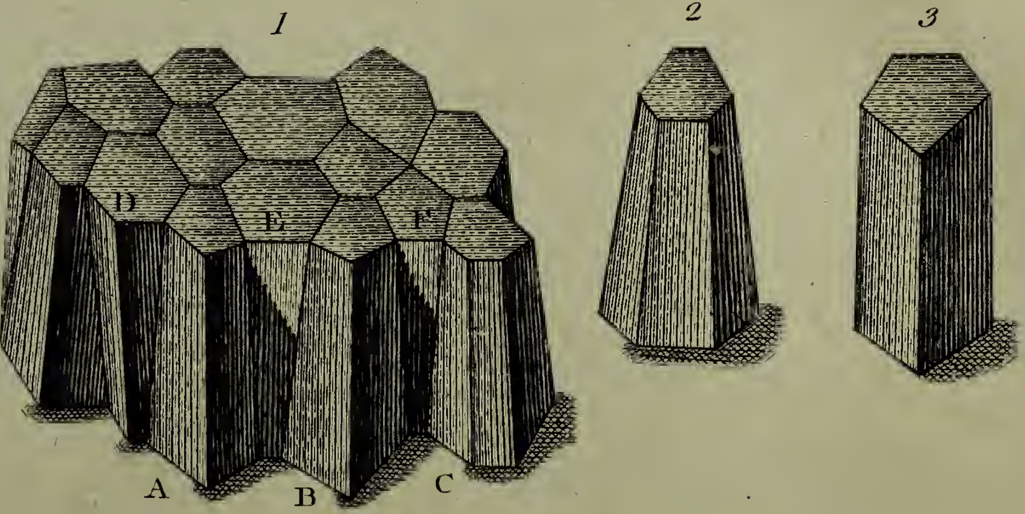


Fig. 2



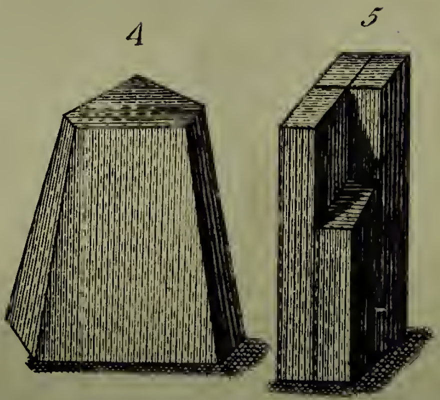
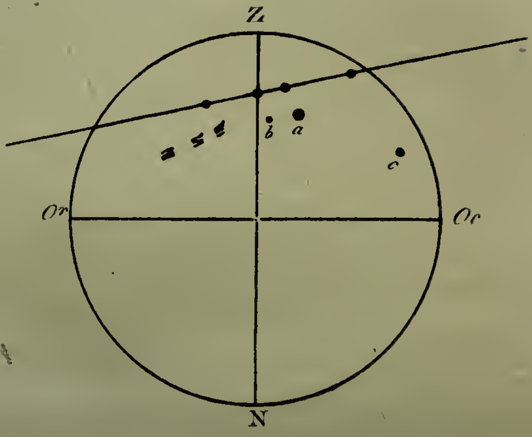


Fig. 3



ſo thick, that the compaſs of twelve or fifteen yards a boat load, from three to five tons, might have been taken up: that he meaſured ſeveral of the haddocks, from two to two feet eight inches in length, and ſix or ſeven inches deep; about twice the ſize of haddocks on our coaſts. That he opened all the haddocks he took on board, and in every one of them, both dead and expiring, he ſaw the *ſound* much inflated or blown up, to which he aſcribes the great deſtruction, but without being able to give any further ſatisfactory reaſon.

Mr. Stoker went from Archangel to Onega; and when Mr. Armſtrong, at the former place, related the ſtory to the merchants and inhabitants at the Exchange, they replied, that they had known and heard of ſimilar accidents; and that the great quantity of thunder and lightning, uſual near the Cape, was the reaſon."

XIX. *On the Cauſe of the additional Weight which Metals acquire by being calcined. In a Letter from* George Fordyce, *M. D. F. R. S.*

IT has been a great deſideratum among chemiſts to determine the cauſe of the additional weight which metals acquire when they are calcined. This is the object of the experiments.

A piece of zinc perfectly free from iron was diſſolved in vitriolic acid, and precipitated by means of an alkali, which after being expoſed to the air remained perfectly white. This was reduced to its metallic ſtate and rediſſolved, and again precipitated.

The weight of the calx being greater than the metal from which it was obtained, ſhewed either that a ſubſtance is added to the whole metal, or that while ſome ſubſtance is driven off, another is added in greater quantity.

" This additional matter muſt be added to the metal, either from the acid, the " alkali, the water uſed in the ſolution, the air lying on the materials during the time " of the operation, or it muſt come through the veſſels in which the operation is " performed." This was the next object of enquiry.

Purified vitriolic acid was diluted to about four or five times its weight of water. Having found by previous experiments that it required 10148 grains of the aqua kali puri of the London Diſpenſary to ſaturate 1000 grains of the diluted acid, and that from this quantity of ſaturated ſolution 978 grains of kali vitriolatum evaporated to dryneſs, was to be obtained.

Dr. Fordyce took 1000 grains of the diluted acid and put it into a veſſel of the form in the figure annexed (Plate VIII. Fig. 1.) and added zinc, till it would diſſolve no more. The inflammable air which eſcaped, weighed 9 grains. That part of the veſſel marked A contained the ſolution, and the apparatus was laid on its ſide. Then 10148 grains of the aqua kali vitriolate was poured by a bent funnel into B, and the tube D being hermetically ſealed, the whole was accurately weighed. The veſſel was then raiſed, and the zinc precipitated in the form of a calx. No alteration of gravity took place, and when breaking the tube under water in an atmoſphere of the ſame heat in which it was ſealed, the air was found neither increaſed, nor diminiſhed. The weight of the calx therefore, was not obtained from the ſuperincumbent air, nor from any thing having paſſed through the glaſs. Neither did it ariſe from the acid, or alkali, for after having waſhed away the whole ſolution from the calx, and evaporated to dryneſs by means of a red heat 976$\frac{1}{16}$ grains of vitriolated tartar were obtained. The increaſe of weight therefore was from the water.

The weight of the zinc diſſolved was 164 grains, the calx of which, after being dryed by a red heat weighed 220 grains. The additional weight then was 56 grains. The water was found by experiments to have loſt 63 grains, and therefore it had yielded the matter occaſioning the additional weight of the calx, and alſo the inflammable air.

XX. *On the Civil Year of the Hindoos, and its Diviſions; with an Account of three Hindoo Almanacs.* By Henry Cavendish, *Eſq.*

ONE of theſe almanacs was computed from Benares, the ſecond was adapted to the ſame place, and the third from Nadeea, a town of Bengal, about 50 miles N. of Calcutta.

The aſtronomical year begins at the inſtant when the ſun comes to the firſt point of the Hindoo zodiac. In the year 1792, it began April 9, at 22*h* 14′ after midnight of the firſt meridian, which is 41′ of time W. of Calcutta. This year is divided into twelve months, correſponding with the ſun's ſtay in ſome ſign, the civil day begins at ſun riſe, and is divided into 60 parts called *dandas*, which are again decided into ſixty *palas*.

In thoſe parts of India in which this almanac is uſed, the civil year is luniſolar, conſiſting of twelve lunar months, and an intercalary month, the lunar month is divided into thirty parts, called teethees, theſe are equal to the time in which the moon's true motion from the ſun is 12°. The civil day is called by the ſame number as the teethee which expires that day. When there are two teethees in one day, there is a gap made in order of the days. The days are counted from the new and full moon, except the laſt which is called the 30th.

The civil month begins at the day of the new moon, the names of the months, of the ſigns, and of the time when the ſun entered that ſign, is given in the following table for 1784-5.

Civil Month.	Sign.	Day on which the ⊙ enters it.			
		1784.			
			day.	dan.	pa.
Viſakha	Meſha	April	9,	37,	7
Jyeſhtha	Vreeſha	May	10,	34,	8
Aſhara	Meetoona	June	11,	0,	8
Sravana	Karkata	July	12,	37,	58
Bhadra	Seengha	Auguſt	13,	7,	11
Aſweena	Kanya	September	13,	7,	36
Karteeka	Toola	October	13,	32,	55
Margaſeerſha	Vreeſcheeka	November	12,	25,	38
Powſha	Dhanoo	December	11,	54,	18
		1785.			
Magha	Makara	January	10,	13,	11
Phalgoona	Koombha	February	8,	40,	21
Chitra	Meena	March	10,	30,	38

It appears by the Benares almanacs, that it is not cuſtomary to date by the ſolar month, but in the Nadeea almanac the caſe is different; there are alſo ſome variations in the two almanacs. No intercalary month occured in the year in which theſe almanacs were printed, but by analogy, we may conclude that theſe lunar months in which the ſun enters no ſign, are intercalary, and are called by the name of the adjoining month with ſome addition.

The Hindoos of Bengal date according to ſolar time, and uſe what is called the Bengal era, but the Brahmins generally note the *teethee.* Thus the Hindoos civil month depends ſolely on the motion of the ſun and moon, and they regulate their times for obſerving religious ceremonies by the almanac publiſhed at *Benares*, *Tirhut*, and *Nadeea.*

The two Benares almanacs begin with a preface, containing an invocation to the deity, an account of the four Yoogas, and the preface concludes with ſome aſtronomical remarks. The calendar contains one page for each half of the month, and is divided into eleven columns, the firſt the day of the month according to the civil reckoning, the ſecond the day of the week, the two next the time of the day on which the *teethee* ends. The fifth the name of *nakſhatra*, or the lunar manſion, which the moon quits in the courſe of the day, and the two next the time in which ſhe quits it. The three next ſhew the moon's place in what may be called the moon's zodiac, Mr. Cavendiſh ſees no uſe in theſe columns, except that of aſtrology; the laſt column is the day of the month uſed by the Mahomedans.

Underneath theſe eleven columns are tables of the diurnal motion and places of the ſun and five planets, and of the moon's node in the Hindoo zodiac, for each week of the year; and between theſe tables and the eleven columns is ſet down the day of the month and week, and number of the week for which theſe places are given, and alſo the interval at that time between ſun-riſe and midnight, and the length of the day. The day of the week for which theſe places are given, is that which is the firſt in the current ſolar year, and the number of the week is alſo counted from the beginning of the ſolar year. The places are given for midnight.

On the right hand of the eleven principal columns is a ſpace allotted for miſcellaneous occurrences. In this is ſet down the time at which the ſun enters each ſign, and the beginning and end of eclipſes. In theſe two years no ſolar eclipſes were viſible, but the end of the lunar eclipſe is denoted by a Sanſkreet word, ſignifying delivery; the meaning of the term uſed for the beginning is not ſo clear. The number of digits eclipſed is not ſet down. The other articles in this ſpace conſiſt chiefly of the time at which the moon and planets come to certain ſituations. Of this there is a great deal which Mr. Cavendiſh ſays he does not underſtand. There are alſo ſome figures and tables between the preface and calendar, which, as far as he can find, relates only to aſtrology.

XXI. *On Evaporation.* *By* JOHN ANDREW DE LUC, *Eſq. F. R. S.*

MR. de Luc from the time he fixed his attention on evaporation, conceived that that phænomenon was operated by fire, independent of air. The principal reaſon for this belief was, that every liquor is known to cool whilſt it evaporates, which ſeemed to prove to him, that the portion of liquor which diſappears is carried away by a quantity of fire, proceeding from the liquid itſelf. This opinion was much ſtrengthened by an experiment of Mr. Watts, the inventor of the ſteam engine, by which it was demonſtrated, "that in the common evaporation in the air, the quantity of heat loſt by the maſs, bears to the quantity of water carried away, a proportion ſtill greater than that which is found in the ſteam of boiling water. Therefore there is no reaſon to doubt that ſteam is formed in the firſt, as in the laſt of theſe caſes."

Before proceeding, however, to the relation of the experiments he made uſe of, Mr. de Luc thinks it neceſſary to relate how Hygrometry and Hygrology are connected, which he does by ſtating the principles of theſe two branches of natural philoſophy according to his own ſyſtem.

On the Laws of Hygrology.

1. Steam is an expanſible fluid compoſed of fire and water, and produced by evaporation.

2. Although elaſtic, it is not permanently ſo; for it may be decompoſed by certain degrees of preſſure, or cooling.

3. Its characteric property is its having a fixed maximum of denſity which increaſes with the temperature.

4. The degree of preſſure exerciſed by it, or which it can ſupport without decompoſition being *cæteris paribus* proportional to its denſity, it depends alſo on temperature.

5. Steam may be formed in every temperature, provided it has not to repel a power ſuperior, even in the ſmalleſt degree, to its maximum of power by the actual temperature.

6. From the foregoing, the degree of heat requiſite to make water boil, and the variations of that degree under different preſſures, is determined.

7. The difference between the phænomena of evaporation, and ebullition, are alſo determined by the ſame law; for if in the latter a certain degree of heat is required, it is only becauſe the ſteam cannot be formed within the water, without a ſufficient degree of denſity for overcoming the preſſure of the atmoſphere on the ſurface of the water; whereas in evaporation the ſteam is formed at the ſurface of the water in every temperature, as it meets with no reſiſtance which it cannot overcome.

8. Steam by evaporation, and ebullition are exactly of the ſame kind, and in reſpect of the preſſure it undergoes, it is in the ſame ſtate as when produced by evaporation, under an exhauſted receiver, its preſſure being proportional to its own power; and in the open air the part of the whole preſſure incumbent on ſteam is to that whole, as its power is to that of the whole maſs.

9. An experiment proving the foregoing law. "The thermometer being at about 65° of Farenheit, the maximum of evaporation in an exhauſted receiver, keeps a column of quickſilver of 0,5 inch ſuſpended in the ſhort manometer."

10. A barometer being incloſed in a receiver full of air of the ſame temperature as above, the mercury of the barometer will be made to riſe 0,5 inch by the introduction of a ſufficient quantity of water to produce the maximum of evaporation.

11. Now as it appears that the barometer is in every caſe a manometer, we ſhall find the greateſt analogy between thoſe phænomena obſerved in cloſe veſſels and what happens to ſteam in the atmoſphere; for it is a meaſure both of the weight of the incumbent column of air, and alſo of the denſity of the fluid. Therefore when ſteam is mixed with air, be the maſs ſhut up in a veſſel, or be it a certain part of the

atmoſphere diſtinct by its place, both fluids will act on the column of the manometer or barometer, or on every obſtacle, and thus againſt each other, according to their reſpective power, for this fundamental reaſon: "That no mechanical cauſe can pro-
"duce the decompoſition of that fluid, but by forcing its particles to come nearer
"each other than the actual temperature can permit:" which caſe cannot happen in the atmoſphere, except by the accumulation of ſteam itſelf in ſome part of it.

Of the laws of Hygrometry.

The ſcience of Hygrometry teaches the reaſon why the denſity of ſteam has different maxima of denſity in different temperatures.

The aqueous particles of ſteam have a tendency to unite at a certain diſtance. The leſs the quantity of free fire (or of the cauſe of heat) in a ſpace, the greater the diſtance, and *vice verſa*. Precipitation of water from ſteam begins when the denſity of ſteam is arrived beyond its limits, and thoſe limits depend on the proportion of free fire, ſince, it is by that the attraction between the particles is regulated. This is common to Hygrometry and Hygrology.

"Hygroſcopic ſubſtances are of three diſtinct claſſes. Some ſeize on the water of ſteam, by a chemical affinity with that liquid; among theſe are acids, ſalts, and calces. Some only imbibe it by its tendency to propagate itſelf in capillary pores; but, from their nature they receive no ſenſible increaſe in their bulk by its introduction; in the number of theſe are porous ſtones. Laſtly, ſome ſubſtances, which alſo only imbibe a certain quantity of water, are thereby expanded; and theſe are moſt of the ſolids belonging to the vegetable and animal kingdoms."

The laſt ones only appear to be proper for the purpoſes of Hygrometry, and of theſe M. de Luc means only to conſider thoſe which ceaſe to lengthen when they cannor imbibe more moiſture.

Moiſture in a general ſenſe may be conſidered as inviſible water producing obſervable phænomena. In reſpect to Hygrometry, where it is conſidered as having correſpondent degrees in the medium and in hygroſcopic bodies, moiſture may be either totally abſent or extreme in both, which forms a fixed module for determining correſpondent degrees; but theſe modules are not of the ſame nature, and thence in relation to one another, moiſture aſſumes in the medium the character of a cauſe, and in hygroſcopic bodies that of an effect.

The quantity of water which any hygroſcopic bodies can admit is fixed, ſince it is determined by the capacity of its pores, but the quantity of water producing extreme moiſture in a medium of a given extent, is as various as the temperature, therefore the equilibrium between the medium and hygroſcopic body, which is the object of hygrometry as a ſcience, does not depend on certain quantities of water contained in the firſt, but on different aptitudes of ſteam to communicate water to thoſe bodies.

7. In order to aſſign the cauſe of that equilibrium, we have previouſly to determine, 1. Whence proceeds a maximum of length in the hygroſcopic bodies here referred to; 2. How that maximum is produced by ſteam; 3. Why it takes place by different denſities of that fluid, when the temperature is different.

The lengthening of the hygroſcopic body is determined when the diſtending power (the moiſture) cannot any longer overcome the attraction which exiſts between the particles of the body itſelf.

The maximum of length of thoſe bodies is produced whenever ſurrounded by a ſufficient quantity of water or moiſture, which has no greater tendency elſewhere; ſuch as when immerſed in water or ſurrounded by ſteam arrived at its maximum of denſity.

The phænomena of the hygroſcopic equilibrium between the medium and body, are to be explained as follows.

In conſequence of the compoſition of ſteam, whatever be its quantity in a given ſpace, its aptitude of communicating to water the hygroſcopic body is always proportional to the actual ratio between that quantity, and the maximum correſponding to the temperature; which ratio, and not an abſolute quantity of ſteam, characterizes a certain degree of moiſture in the medium. Moiſture in the medium is greater and is retained by the hygroſcopic in greater quantity when the actual quantity of ſteam bears a greater proportion with its maximum correſpondent to the temperature, and *vice verſa*. Therefore the inſtrument marks the degree of moiſture; but without any reference to the denſity of ſteam. In order to aſcertain this we muſt always know the temperature.

Such are the proportions which connect Hygrology with Hygrometry, and the only part remaining to be proved is, "That in vacuo, as in air, the product of evaporation "affects the Hygroſcope as it does the Manometer."

The inſtruments made uſe of were Mr. de Luc's whalebone Hygrometer, and Mr. Haas's Air Pump, wet cloths were placed at the bottom of the receiver, and obſervations taken at different periods of rarity of the air.

Beſides the general concluſion derived from theſe experiments, ſtated at the beginning of this paper, the following reſults were alſo drawn from them.

When ſome laſting cauſe of formation of ſteam exiſts within the air pump, and the air is almoſt completely exhauſted, the remaining preſſure on the manometer is that of ſteam.

The law of ſteam is ſubject to anomalies, and principally to that of two diſtinct maxima, one of production, the other of preſervation. Theſe coincide near the freezing point; hence the Hygrometer ſtands there at 100, which is its point of extreme moiſture, but in proportion as the temperature is encreaſed the maximum of production falls ſhort of that of preſervation, and thereby the Hygrometer recedes from extreme moiſture. Other occaſional anomalies may alſo ariſe from various cauſes, among which are the following.

"If the water that evaporates is warmer than the ſpace which receives the ſteam, more moiſture is produced in that ſpace, or the quantity of ſteam is greater in it than by an equal temperature in both; and *vice verſa*. More or leſs diſtance of the part of the ſpace where the Hygrometer ſtands from the ſides of the veſſel, produces alſo anomalies; as according to their own ſtate of moiſture, if near enough, they have an influence on moiſture in that ſpace, as I have explained in my former paper; and this is often the caſe in ſome meaſure when the veſſels are too ſmall. Laſtly, differences in the temperature of the whole or of ſome part of the veſſel, comparatively with that of the ſpace, are the moſt common cauſes of anomalies; for ſteam is alternately decompoſed and reproduced by thoſe differences, and when they have once begun in a veſſel, there is no certain means to bring it to a regular courſe of phænomena, except by beginning again, or by a long equal temperature."

XXII. *Supplement*

TABLE I.

Weights at the different degrees of temperature.

ce p. 175.

Heat.	The pure ſpirit.	100 grains of ſpirit to 5 grains of water.	100 grains of ſpirit to 10 grains of water.	100 grains of ſpirit to 15 grains of water.	100 grains of ſpirit to 20 grains of water.	100 grains of ſpirit to 25 grains of water.	100 grains of ſpirit to 30 grains of water.	100 grains of ſpirit to 35 grains of water.	100 grains of ſpirit to 40 grains of water.	100 grains of ſpirit to 45 grains of water.	100 gr of ſpir 50 gra of wa	ains it to ins ter.	100 grains of ſpirit to 65 grains of water.
°	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grai	ns.	Grains.
30	2487,35	2519:92	2548,42	2573,80	2596,66	2617:30	2636,23	2653,73	2669,83	2684,74	2698	,89	2733,87
35	2480,87	2513,43	2541,84	2567,26	2590:16	2610,87	2629,92	2647:47	2663,64	2678,60	2692	,92	2727,87
40	2474:30	2506,75	2535:41	2560,74	2583,66	2604:50	2623:56	2641,08	2657,23	2672,30	2686	,81	2721,83
45	2467,62	2500,14	2528,75	2554,09	2577,10	2597:98	2617:03	2634,64	2650,87	2666,04	2679	,57	2715,62
50	2460,75	2493,33	2521,96	2547:47	2570,42	2591:38	2610:54	2628,21	2644,43	2659,55	2673	:42	2709,48
55	2453:80	2486,37	2515,03	2540,60	2563,64	2584,65	2603,80	2621:50	2637,86	2653,04	2667	,83	2702,98
60	2447,00	2479:56	2508,27	2533,83	2556,90	2577,95	2597:22	2615:03	2631:37	2646,53	2660	:52	2696,73
65	2440,12	2472:75	2501,53	2526,99	2550,22	2571,24	2590,55	2608,37	2624,75	2640,01	2654	:15	2690,32
70	2433,23	2465,88	2494,56	2520,03	2543,32	2564,47	2583,88	2601,67	2617,96	2633,32	2647	·74	2684,02
75	2426,23	2458,78	2487,62	2513:08	2536,39	2557,61	2576,93	2594,80	2611,19	2626,55	2640,	,06	2677:34
80	2419,02	2451,67	2480,45	2506,08	2529,24	2550:50	2569,86	2587,93	2604,29	2619:72	2633,	:36	2670,69
85	2411.92	2444,63	2473·33	2499,01	2522,29	2543:54	2563,01	2580,93	2597,45	2613,02	2627,	:78	2664,16
90	2404,90	2437,62	2466,32	2491,99	2515,28	2536,63	2556,11	2574,02	2590,60	2606,16	2620,	,00	2657:41
95	2397,68	2430:33	2459,13	2484,74	2508,10	2529,46	2549,13	2567,03	2583,65	2599:24	2613,	,25	2650,63
100	2390,60	2423,22	2452,13	2477,64	2500:91	2522:30	2541,92	2559,96	2576,56	2592,14	2606,	,17	2643,75

Heat.	100 grains of ſpirit to 70 grains of water.	100 grains of ſpirit to 75 grains of water.	100 grains of ſpirit to 80 grains of water.	100 grains of ſpirit to 85 grains of water.	100 grains of ſpirit to 90 grains of water.	100 grains of ſpirit to 95 grains of water.	100 grains of ſpirit to 100 grains of water.	95 grains of ſpirit to 100 grains of water.	90 grains of ſpirit to 100 grains of water.	85 grains of ſpirit to 100 grains of water.	80 grai of ſpirit 100 grai of water	ins it to ains ter.	65 grains of ſpirit to 100 grains of water.
°	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains	ns.	Grains.
30	2744,20	2753,75	2762,72	2771,08	2778,99	2786,36	2793,22	2799,85	2806,61	2813,85	2821,3	6,39	2844,16
35	2738,13	2747:74	2756,91	2765,32	2773,22	2780,59	2787,54	2794·19	2801,14	2808,52	2816,0	1·36	2839,26
40	2732,24	2741,86	2750,96	2759,50	2767,48	2774,90	2781,84	2788,69	2795,70	2803,17	2810,7	6,31	2834,40
45	2726,09	2735·77	2744,82	2753,36	2761,42	2768,85	2775,94	2782,99	2789,99	2797,45	2805,0	1,00	2829,28
50	2719·93	2729,64	2738,74	2747,27	2755,37	2762,95	2770,14	2777,19	2784,30	2791·72	2799,5	5,71	2824,12
55	2713,60	2723,51	2732,64	2741,24	2749,27	2756,83	2764,09	2771,29	2778,54	2785,96	2793,8	810,23	2818,80
60	2707·40	2717,30	2726,52	2735,17	2743,28	2750,93	2758,17	2765,40	2772,70	2780,26	2788,2	804,85	2813,65
65	2701,05	2710,96	2720,25	2728,98	2737,09	2744,86	2752,21	2759,47	2766,73	2774,43	2782,6	799·38	2808,31
70	2694,76	2704,64	2713,87	2722·75	2730,94	2738,73	2746,06	2753,41	2760,75	2768,45	2776,7	793,80	2802,88
75	2688,14	2698,07	2707,49	2716,35	2724,64	2732,39	2739,89	2747,23	2754·73	2762,58	2770,9	83,00	2797:21
80	2681,50	2691,50	2700,94	2709,76	2718,12	2726,06	2733,53	2740,93	2748,42	2756,43	2764,8	82,14	2791,52
85	2674·95	2684,98	2694·53	2703,33	2711·86	2719,74	2727,25	2734,80	2742,31	2750,22	2758,8	6,33	2785,81
90	2668,29	2678,49	2687,99	2696,91	2705,37	2713,32	2721,01	2728,59	2736,23	2744,24	2752,76	70:59	2780,11
95	2661,51	2671,82	2681·34	2690,33	2698,86	2706,88	2714·61	2722,23	2729,89	2737,98	2746,57	4:57	2774,25
100	2654,76	2664,99	2674,62	2683·63	2692,25	2700,33	2708,04	2715,73	2723,35	2731,55	2740,43	58,48	2768,43

Heat.	60 grains of ſpirit to 100 grains of water.	55 grains of ſpirit to 100 grains of water.	50 grains of ſpirit to 100 grains of water.	45 grains of ſpirit to 100 grains of water.	40 grains of ſpirit to 100 grains of water.	35 grains of ſpirit to 100 grains of water.	30 grains of ſpirit to 100 grains of water.	25 grains of ſpirit to 100 grains of water.	20 grains of ſpirit to 100 grains of water.	15 grains of ſpirit to 100 grains of water.	10 grains of ſpirit to 100 grains of water.	ter.	
°	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	ins.	
30	2852,03	2859,71	2867,12	2874·43	2881·34	2887:77	2894,22	2900,85	2908,21	2917,19	2928,80		
35	2847,45	2855,32	2863,16	2870,87	2878,21	2885,06	2892:07	2899,31	2907,45	2916,95	2928,99	7:14	
40	2842,62	2850.88	2859,06	2867:08	2874,81	2882,30	2889:78	2897,61	2906,39	2916,41	2928,93	,45	
45	2837,64	2846,16	2854,67	2863,04	2871,22	2879,22	2887,33	2895,67	2904·98	2915:55	2928,49	,40	
50	2832,76	2841,52	2850,29	2858,96	2867:52	2875,98	2884,57	2893:58	2903:39	2914,42	2927:81	:05	
55	2827,68	2836,69	2845,72	2854:75	2863,75	2872,67	2881,69	2891,11	2901,42	2913,02	2926,73	,34	
60	2822,65	2831,90	2841,10	2850,50	2859,87	2869,15	2878,72	2888,62	2899,35	2911,32	2925,50	,39	
65	2817:49	2826,90	2836,30	2845,97	2855,65	2865,45	2875,49	2885,85	2897:09	2909:43	2923,90	,11	
70	2812,16	2821·78	2831,61	2841·42	2851:53	2861,63	2872,06	2882,90	2894,56	2907:33	2922,24	,66	
75	2806,75	2816,63	2826,56	2836,80	2847,14	2857·70	2868:49	2879,67	2891·79	2905,04	2920,17	,97	
80	2801·25	2811,23	2821:38	2831,92	2842:56	2853,38	2864,54	2876,22	2888,73	2902:35	2917,83	,07	
85	2795,69	2805,85	2866,32	2827,12	2838,07	2849,28	2860,86	2872,88	2885,56	2899·55	2915:46	,94	
90	2790,13	2800,40	2811,05	2822,15	2833·38	2844,81	2856,80	2869,16	2882,25	2896,58	2912,84	,70	
95	2784:36	2794,91	2805,79	2817:08	2828,46	2840,26	2852,47	2865,15	2878,71	2893:44	2910,02	,08	
100	2778,64	2789,32	2800,25	2811,80	2823,55	2835:30	2848,18	2861,12	2875:07	2890,04	2906,97	,34	

TABLE II.

Real ſpecific gravities at the different temperatures.

[To face p. 175.

Heat.	The pure ſpirit.	100 grains of ſpirit to 5 grains of water.	100 grains of ſpirit to 10 grains of water.	100 grains of ſpirit to 15 grains of water.	100 grains of ſpirit to 20 grains of water.	100 grains of ſpirit to 25 grains of water.	100 grains of ſpirit to 30 grains of water.	100 grains of ſpirit to 35 grains of water.	100 grains of ſpirit to 40 grains of water.	100 grains of ſpirit to 45 grains of water.	100 grains of ſpirit to 50 grains of water.	100 grains of ſpirit to 55 grains of water.	100 grains of ſpirit to 60 grains of water.	100 grains of ſpirit to 65 grains of water.
30°	,83896	,84995	,85957	,86825	,87585	,88282	,88921	,89511	,90054	,90558	,91023	,91449	,91847	,92217
35	,83672	,84769	,85729	,86587	,87357	,88059	,88701	,89294	,89839	,90345	,90811	,91241	,91640	,92009
40	,83445	,84539	,85507	,86361	,87134	,87838	,88481	,89073	,89617	,90127	,90596	,91026	,91428	,91799
45	,83214	,84310	,85277	,86131	,86907	,87613	,88255	,88849	,89396	,89909	,90380	,90812	,91211	,91584
50	,82977	,84076	,85042	,85902	,86676	,87384	,88030	,88626	,89174	,89684	,90160	,90596	,90997	,91370
55	,82736	,83834	,84802	,85664	,86441	,87150	,87796	,88393	,88945	,89458	,89933	,90367	,90768	,91144
60	,82500	,83599	,84568	,85430	,86208	,86918	,87568	,88169	,88720	,89232	,89707	,90144	,90549	,90927
65	,82262	,83362	,84334	,85193	,85976	,86686	,87337	,87938	,88490	,89006	,89479	,89920	,90328	,90707
70	,82023	,83124	,84092	,84951	,85736	,86451	,87105	,87705	,88254	,88773	,89252	,89695	,90104	,90484
75	,81780	,82878	,83851	,84710	,85493	,86212	,86864	,87466	,88018	,88538	,89018	,89464	,89872	,90252
80	,81530	,82631	,83603	,84467	,85248	,85966	,86623	,87228	,87776	,88301	,88781	,89225	,89639	,90021
85	,81283	,82386	,83355	,84221	,85006	,85723	,86380	,86984	,87541	,88067	,88551	,88998	,89409	,89793
90	,81039	,82142	,83111	,83977	,84762	,85483	,86139	,86743	,87302	,87827	,88312	,88758	,89173	,89558
95	,80788	,81888	,82860	,83724	,84511	,85232	,85896	,86499	,87060	,87586	,88069	,88521	,88937	,89322
100	,80543	,81643	,82618	,83478	,84262	,84984	,85646	,86254	,86813	,87340	,87824	,88271	,88691	,89082

Heat.	100 grains of ſpirit to 70 grains of water.	100 grains of ſpirit to 75 grains of water.	100 grains of ſpirit to 80 grains of water.	100 grains of ſpirit to 85 grains of water.	100 grains of ſpirit to 90 grains of water.	100 grains of ſpirit to 95 grains of water.	100 grains of ſpirit to 100 grains of water.	95 grains of ſpirit to 100 grains of water.	90 grains of ſpirit to 100 grains of water.	85 grains of ſpirit to 100 grains of water.	80 grains of ſpirit to 100 grains of water.	75 grains of ſpirit to 100 grains of water.	70 grains of ſpirit to 100 grains of water.	65 grains of ſpirit to 100 grains of water.
30°	,92563	,92889	,93191	,93474	,93741	,93991	,94222	,94447	,94675	,94920	,95173	,95429	,95681	,95944
35	,92355	,92680	,92986	,93274	,93541	,93790	,94025	,94249	,94484	,94734	,94988	,95246	,95502	,95772
40	,92151	,92476	,92783	,93072	,93341	,93592	,93827	,94058	,94295	,94547	,94802	,95060	,95328	,95602
45	,91937	,92264	,92570	,92859	,93131	,93382	,93621	,93860	,94096	,94348	,94605	,94871	,95143	,95423
50	,91723	,92050	,92358	,92647	,92919	,93177	,93419	,93658	,93897	,94149	,94414	,94683	,94958	,95243
55	,91502	,91837	,92145	,92436	,92707	,92962	,93208	,93452	,93696	,93948	,94213	,94486	,94767	,95057
60	,91287	,91622	,91933	,92225	,92499	,92758	,93002	,93247	,93493	,93749	,94018	,94296	,94579	,94876
65	,91066	,91400	,91715	,92010	,92283	,92546	,92794	,93040	,93285	,93546	,93822	,94099	,94388	,94689
70	,90847	,91181	,91493	,91793	,92069	,92333	,92580	,92828	,93076	,93337	,93616	,93898	,94193	,94500
75	,90617	,90952	,91270	,91569	,91849	,92111	,92364	,92613	,92865	,93132	,93413	,93695	,93989	,94301
80	,90385	,90723	,91042	,91340	,91622	,91891	,92142	,92393	,92646	,92917	,93201	,93488	,93785	,94102
85	,90157	,90496	,90818	,91119	,91403	,91670	,91923	,92179	,92432	,92700	,92989	,93282	,93582	,93902
90	,89925	,90270	,90590	,90891	,91177	,91446	,91705	,91962	,92220	,92491	,92779	,93075	,93381	,93703
95	,89688	,90037	,90358	,90662	,90949	,91221	,91481	,91740	,91998	,92272	,92562	,92858	,93170	,93497
100	,89453	,89798	,90123	,90428	,90718	,90992	,91252	,91513	,91769	,92047	,92346	,92646	,92957	,93293

Heat.	60 grains of ſpirit to 100 grains of water.	55 grains of ſpirit to 100 grains of water.	50 grains of ſpirit to 100 grains of water.	45 grains of ſpirit to 100 grains of water.	40 grains of ſpirit to 100 grains of water.	35 grains of ſpirit to 100 grains of water.	30 grains of ſpirit to 100 grains of water.	25 grains of ſpirit to 100 grains of water.	20 grains of ſpirit to 100 grains of water.	15 grains of ſpirit to 100 grains of water.	10 grains of ſpirit to 100 grains of water.	5 grains of ſpirit to 100 grains of water	Water.	
30°	,96209	,96470	,96719	,96967	,97200	,97418	,97635	,97860	,98108	,98412	,98804	,99334		
35	,96048	,96315	,96579	,96840	,97086	,97319	,97556	,97801	,98076	,98397	,98804	,99344	1,00090	
40	,95879	,96159	,96434	,96706	,96967	,97220	,97472	,97737	,98033	,98373	,98795	,99345	1.00094	
45	,95705	,95993	,96280	,96563	,96840	,97110	,97384	,97666	,97980	,98338	,98774	,99338	1,00086	
50	,95534	,95831	,96126	,96420	,96708	,96995	,97284	,97589	,97920	,98293	,98745	,99316	1,00068	
55	,95357	,95662	,95966	,96272	,96575	,96877	,97181	,97500	,97847	,98239	,98702	,99284	1,00038	
60	,95181	,95493	,95804	,96122	,96437	,96752	,97074	,97409	,97771	,98176	,98654	,99244	1,00000	
65	,95000	,95318	,95635	,95962	,96288	,96620	,96959	,97309	,97688	,98106	,98594	,99194	,99950	
70	,94813	,95139	,95469	,95802	,96143	,96484	,96836	,97203	,97596	,98028	,98527	,99134	,99894	
75	,94623	,94957	,95292	,95638	,95987	,96344	,96708	,97086	,97495	,97943	,98454	,99066	,99830	
80	,94431	,94768	,95111	,95467	,95826	,96192	,96568	,96963	,97385	,97845	,98367	,98991	,99759	
85	,94236	,94579	,94932	,95297	,95667	,96046	,96437	,96843	,97271	,97744	,98281	,98912	,99681	
90	,94042	,94389	,94748	,95123	,95502	,95889	,96293	,96711	,97153	,97637	,98185	,98824	,99598	
95	,93839	,94196	,94563	,94944	,95328	,95727	,96139	,96568	,97025	,97523	,98082	,98729	,99502	
100	,93638	,93999	,94368	,94759	,95152	,95556	,95983	,96424	,96895	,97401	,97969	,98625	,99402	

XXII. *Supplementary Report on the beſt Method of proportioning the Exciſe on Spirituous Liquors.* *By* CHARLES BLAGDEN, *M. D. F. R. S.*

IN the report on the firſt experiments to which this is a ſupplement, Dr. Blagden introduced the following remark. "It muſt be obſerved, that Mr. Gilpin uſed "the ſame mixture throughout all the different temperatures, heating it up from 30° "to 100°; hence ſome ſmall error in its ſtrength may have been occaſioned, in the "higher degrees, by more ſpirit evaporating than water; but this, it is believed, "muſt have been trifling, and greater inconvenience would probably have reſulted "from interpoſing a freſh mixture."

Now it was aſcertained by a ſet of experiments made on purpoſe, that the error was greater than what had been ſuppoſed, though not ſo much as to cauſe a difference of more than a ſingle unite in the third place of decimals, even in the temperature of 100, but ſtill ſufficient to induce Dr. Blagden to repeat all the former experiments, conjointly with a new ſet for alcohol, diluted with more than an equal weight of water, to which length only the firſt ſeries of experiments had gone.

To obviate the error from evaporation, and aſcertain what each mixture loſt of its ſtrength during the operation, all the fluids were firſt weighed at 60° before they were cooled down to 30°; from 30° to 100° they were weighed at every 5° as before, conſequently twice at 60°, and laſtly, being heated to 100°, and brought down to 60° they were weighed once more.

The funnel was made to hold only fifteen grains of ſpirits.

Under theſe precautions the two adjoining tables are drawn up like the tables in the former report, but, as alcohol was taken for the fixed quantity in the firſt half, ſo water is taken for the fixed quantity in the laſt half, which, therefore, conſiſts of mixtures containing all 100 grains of water, with 95 grains, 90, 85, and ſo on ſucceſſively, of alcohol, till the laſt column is pure water. This arrangement will be clear to every one, on reading the title of each column of the tables. The firſt table gives the actual weights, at the even degree of the thermometer, corrected for the evaporation; and the ſecond table gives the ſpecific gravities, calculated from thoſe weights, with the ſame allowance and corrections as were ſpecified in the original Report.

Nouveaux Memoires de l' Academie Imperiale et Royale de Sciences & Belles Lettres de Bruſſels. Tome Premier.

New Memoirs of the Imperial and Royal Academy of Sciences and Belles Letters, at Bruſſels. Vol. I. 4to. 1788. *Part* I. *Sciences and Arts.*

THE Bruſſels Academy had already publiſhed four volumes of Memoirs, when they determined upon commencing a new ſeries, under the preſent title. This has induced us, though the date runs farther back than the limit of our propoſals, to include it within our plan, that our readers may poſſeſs a complete view of this national work, according to its preſent and future eſtabliſhment.

With reſpect to the *Hiſtory of the Academy*, and the *Analyſes of Memoirs of an old date*, with which the volume commences, we ſhall paſs them over as carrying us further than is neceſſary for our purpoſe; and ſhall begin with the firſt paper of the new ſeries.

A general View of the lateſt Advancements in the Academical Sciences, and of what remains to carry them nearer to Perfection. By the Abbe Mann.

AFTER ſome obſervations on the utility of ſuch general views, the writer goes through an enumeration of the particular ſubjects in queſtion. He begins with *Mathematics*, in the higheſt branches of which he finds little done ſince the labours of Newton and Leibnitz, except attempts to facilitate and generaliſe the modes of calculation which they had invented. Several obſcurities ſtill remain to be cleared up in pure *analyſis*, and in the calculation of *infiniteſimals*. A general method, not by approximation, but by which an abſolute integration of all poſſible ſeries might be arrived at, is the great diſcovery ſtill to be made.

Aſtronomy has within a few years made great advances, by the invention of achromatic teleſcopes, the obſervations made in different parts of the globe of the tranſit of Venus, and other celeſtial phænomena, and particularly by the diſcovery of a new planet, and of an infinite number of fixed ſtars, by Herſchel.

The improvements in *Geography* are very conſiderable, and are principally owing to the perfection which the *art of navigation* has acquired. By means of the lunar tables and marine watches, the illuſtrious Cook has been able to viſit the remoteſt parts of the globe, and clear up many doubtful points relative to the exiſtence and boundaries of different lands. Still, however, a great deal remains to be done in exploring the internal parts of vaſt tracts, of which little more than the outlines are yet known.

Meteorology, or the knowledge of the atmoſphere, is ſtill in its infancy. Many obſervations have been collected; but no proper analyſis of the ſhare each of the various cauſes of atmoſpherical changes has in their production, which is the only baſis of true ſcience on this ſubject, has hitherto been attempted.

The doctrines reſpecting *air*, *fire*, and the *electric fluid*, have been much elucidated by the enquiries of many ingenious experimentaliſts, but much is ſtill to be done; and the firſt principles of *chymiſtry* are yet to be reduced to certainty.

Mineralogy, and *Metallurgy* have been greatly improved by the Germans and Swedes in particular; *Botany* has had numerous votaries in various countries; and the other branches of *Natural Hiſtory* have been ſtudied with ardour, not only in Europe, but by European travellers in every quarter of the world.

Such are the general views afforded by this paper, which concludes with a compliment to thoſe ſovereigns who diſtinguiſh themſelves as patrons of ſcience.

On the Deluges mentioned by the Ancients; with ſome phyſical and mathematical Conſiderations on theſe Cataſtrophes. By the ABBE MANN.

THE real or fabulous Deluges mentioned by the ancients, may be reduced to ſix or ſeven; and, though ſome authors have endeavoured to repreſent them all as imperfect traditions of the univerſal deluge, the Abbé does not doubt that they refer to various real and diſtinct events of the kind. 1. The ſubmerſion of the *Atlantis* of Plato, probably was the real ſubſidence of a great iſland ſtretching from the Canaries to the Azores, of which thoſe groups of iſlets are the relics. 2. The deluge in the time of *Cadmus* and *Dardanus*, placed by the beſt chronologiſts in the year 1477 B. C. is ſaid by Diodorus Siculus to have inundated Samothrace, and the Aſiatic ſhores of the Euxine ſea. 3. The deluge of *Deucalion* which the Arunidelian marbles fix at 1529 B. C. overwhelmed Theſſaly. 4. The deluge of Ogyges placed by Acuſilaus, in the year anſwering to 1796 B. C. laid waſte Attica and Bœotia. With the poetical and fabulous accounts of Deucalion's flood are mingled ſeveral circumſtances of the univerſal deluge; but the beſt writers atteſt the locality and diſtinctneſs both of the flood of Deucalion, and of Ogyges. 5. Diodorus Siculus, after Manetho, mentions a flood which inundated all Egypt in the reign of *Oſiris*; but in the relations of this event are ſeveral circumſtances reſembling the ſtory of Noah's flood. 6. The account given by Beroſus the Chaldean, of an univerſal deluge, in the reign of *Xiſuthrus*, evidently relates to the ſame event with the flood of Noah. The Perſian Guebres, the Bramins, Chineſe, and Americans have alſo their traditions of an univerſal deluge. The account of the deluge in the *Koran* has this remarkable circumſtance; that the waters which covered the earth are repreſented as proceeding from the boiling over of the cauldron or oven *Tannour*, within the bowels of the earth; and that, when the waters ſubſided, they were ſwallowed up again by the earth. The Abbé then gives a ſummary of the Scripture account of the deluge, from which it clearly appears, that part of the waters came from the atmoſphere, and part from under ground; and then proceeds to his phyſical remarks on the mode by which the event might have been produced.

In order to facilitate the conception, he takes a globe of a toiſe diameter, to which he refers the calculations belonging to the globe of the earth. After comparing the ſolid contents of the earth ſuppoſing it a plain, with that of a concentric globe, paſſing through the ſummit of Chimboraço, (the higheſt known mountain) he finds the difference of the two quantities to amount to $\frac{1}{340\frac{1}{2}}$ of the whole; which laſt is therefore the proportion of a ſpherical ring, reaching from the plain of the earth to the ſummit of Chimboraço, compared with the globe of the earth. The height of this mountain on a globe of a toiſe in diameter would be only $\frac{5}{12}$ of a line. A ſpherical ring of this thickneſs round ſuch a globe would contain as many cubic inches as would equal twelve pints of Paris meaſure, or three gallons Engliſh. Now the Abbé thinks that ſuch a quantity of water thrown out of a globe ſix feet in diameter upon its ſurface, by the force of internal fire, is but a moderate exertion of a power eaſily conceivable.

Diſſertation on the Syrtes, and the Tides of the Mediterranean. By the Abbe Mann.

BY the name of *Syrtes,* the ancients underſtood two large ſhoals ſituated on the African coaſt between Cyreniaca and Byzacene, at the diſtance of 150 leagues aſunder. They called the *Syrtic ſea,* all the ſpace comprehended by the coaſts of thoſe two regions, bounded on the eaſt by Cape Razat, and on the weſt by Cape Bona, forming a vaſt gulph 200 leagues wide, and 80 in depth, open to the north-eaſt. The *great Syrtis* was the eaſternmoſt, in what is now named the Gulph of Sidra. The *little Syrtis* was to the weſt, between the iſle of Jerba (formerly *Meninx* and *Lotophagitis*) and that of Kerkenis, (formerly *Cercina.*) The *Syrtes* are now called the *Shoals of Barbary.*

After this geographical deſcription, the Abbé gives various quotations from ancient authors, in verſe and proſe, to ſhow the terrific ideas always entertained of the ſand banks, proceeding from their ſhifting and uncertain nature, whence they proved the ſure deſtruction of the ſhips engaged among them. He concludes, however, that they were in reality little different from the banks on the coaſt of Flanders; and that the ebbing and flowing ſea covering them, ſo much ſpoken of by the ancients, was no other than the *tides,* regular in calm weather, and irregular in ſtorms.

It is a common opinion that there are no tides in the Mediterranean, but this is not univerſally true. The knowledge of the ancients concerning the tides was very limited; and indeed the ſeas they chiefly frequented could give them no exact ideas of tides. Bernoulli and De la Lande have demonſtrated that in detached ſeas the tides are proportional to their extent in longitude; and from their calculations, the Caſpian, Euxine, Baltic, and great part of the Mediterranean, can have no ſenſible tides for want of longitudinal extent. There are four places in the Mediterranean in which tides are obſerved; in the Syrtic ſea, the Adriatic, the Faro of Meſſina, and the Euripus ſeparating the iſle of Negropont from the main of Greece. The Faro and Euripus being narrow channels, in which the ſea is acted upon by the winds as well as the moon, may be regarded rather as having currents than tides. The Adriatic has a current along its eaſtern ſide which forms regular tides, moſt ſenſible on approaching its extremity. That there are tides in the Syrtic ſea is proved not only from theory, but from the teſtimony of Dr. Shaw, and M. de Chabert, ocular witneſſes. To theſe, then, joined to the looſe light texture of the ſands compoſing the Syrtes, reſembling that of the ſands on the neighbouring deſarts, may be attributed the changeable nature of thoſe famous ſhoals, which in the imperfect ſtate of ancient navigation, might juſtly inſpire dread in mariners. The Flemiſh banks, though more ſolid in their texture, and thoroughly examined in all parts, are even at preſent the cauſe of numerous ſhipwrecks every year.

Memoir on the Cryſtallizations of Water, or Cryſtals of Ice, newly diſcovered. *By* M. DE LAUNAY.

THE winter 1783-4 was extremely ſevere. At the breaking up of the ice in the Danube the obſtruction of the river at Vienna cauſed a great inundation, after the retreat of which a vaſt quantity of large pieces of ice were left behind, which preſented the following phænomena. When they began to feel the influence of the thaw, ſo as to become moiſt on the ſurface, their upper ſuperficies preſented a number of ſmall right lines running in different directions, which together compoſed moſtly hexagonal, ſometimes pentagonal, and rarely quadrilateral figures.

On ſtriking the ſurface vertically with the end of a cane, the cryſtals of which theſe figures were the ſummits, detached like a bundle of faggots, exhibiting priſms, or rather truncated pyramids of ſix, five, or four ſides. The manner in which theſe were united to form the piece of ice was, that they ſtood alternately with their baſes upwards and downwards, ſo as to lock together, and fill up the ſolid contents of the maſs. This circumſtance, with their ſhape, is ſhewn in the annexed plate. See Plate VIII. Fig. 2.

No. 1. is a maſs of ice, in which the truncated pyramids A. B. C. have their baſes turned downwards, and thoſe marked D. E. and F. upwards.

No. 2. is an hexangular truncated pyramid, with three larger and three ſmaller ſides; a large one oppoſite to a ſmall one.

No. 3. A pentagonal truncated pyramid.

No. 4. Alſo pentagonal, but with two ſides ſo ſhort that the whole ſeems rather like a triangle with two of the angles truncated.

No. 5. A four-ſided priſm compoſed of four parallelipipeds, one broken.

The writer has remarked other maſſes of ice, the internal part of which was arranged in *ſtriæ*, ſome as fine as thoſe of Gypſum, others coarſer. Theſe ſtriæ are in reality ſmall priſms united in parallel lines.

In conſidering the mechaniſm by which the cryſtals above deſcribed are formed, M. De Launay infers that the principles of cryſtallization laid down by Macquer, and applied to the formation of ice on the ſurface of ſtill water, viz. that the particles are brought nearer each other by the ſubſtraction of the matter of fire—will not apply in this caſe, ſince the appearance of cryſtals did not take place till after the operation of a warmer air. A more probable explanation of the fact would be, to ſuppoſe that the intromiſſion of particles of fire from the atmoſphere, penetrating the maſs of ice in directions determined by the arrangement of the integral particles of the water, was the agent; or elſe, the beginning diminution in bulk of the ice in the proceſs of thawing, producing internal cracks, in directions ſimilarly determined.

Memoir: What are the Obſtacles to a better Cultivation of the Ardennes, and how are they to be remedied? By the ABBE MARCY.

THE *Ardennes* form a part of the province of Luxemburg. Compared to the fertile province of Flanders, they are more diſtant from the ſea, higher, and colder. They abound in wide commons, which only afford a poor ſuſtenance to a ſmall breed of cattle. The arable lands lie fallow every third year, and produce thin crops of rye or oats. The cauſes of the imperfect culture of this diſtrict are, the attachment of the people to their ſyſtem of commons, whereby they loſe all the advantage of the manure produced by cattle fed in the yard and ſtable, and at the ſame time rear a half-ſtarved breed which yields little milk; and their unwillingneſs or inability to follow an improved plan of farming. The writer is ſenſible, that if in the preſent ſtate of things the commons were taken from the poor, they would be abſolutely ruined; but he would have them gradually brought to rear their cattle at home and ſave the manure, to fold their ſheep part of the year, to be taught by the example of ſome good farmer, encouraged to ſettle there, a better ſyſtem of agriculture; and finally he propoſes that the commons ſhould be divided between the lords and the commoners on certain conditions, with an obligation to put the lots into culture within three years, on pain of forfeiture.

Memoir on the Preſervation of Aliments. By the Abbe Mann.

ALIMENTS are *dry* or *liquid.* The dry are taken from the *animal* or *vegetable* kingdom. It is the preſervation of the latter that is the ſubject of this Memoir. The author begins with a liſt of vegetable aliments, divided into the heads of *Grains*, *Fruits*, *Leaves*, and *Roots*, of which he enumerates above 80 articles. All of theſe he ſuppoſes capable of preſervation in a ſalutary ſtate for a year.

The methods at preſent in uſe for this purpoſe, are;

1. Drying by the open air in the ſhade. This is chiefly employed for medicinal and pot herbs.

2. Drying in the ſun, or by a very moderate fire; as uſed for raiſins, currants, figs, and other dried fruits; and ſago.

3. Drying in an oven. Other fruits. Hops.

4 Grilling upon clean and moderately heated iron plates. The Chineſe prepare tea leaves in this way.

5. Drying by means of a circulation of dry or warm air. M. du Hamel du Monceau propoſed granaries with Hales's ventilators. The Poles and Livonians dry their corn in buildings having a furnace on the ground-floor ſupplied with air only from beneath, which when heated, paſſes through the lares of grain on the upper floors, to an opening in the roof.

6. Baking and re-baking in an oven. Biſcuit ground and preſſed down in iron-hooped caſks will keep a number of years.

7. Salting. This is done either with or without fermenting. The former is the method of preparing ſour krout.

8. Marinating with vinegar, ſalt and pepper. This is practiſed on ſome fruits and tender vegetables.

9. Preſerving with ſugar, the dry and the moiſt way.

10. Preſerving in brandy.

11. Cutting off all communication with the external air, as in covering ſeeds with wax, &c.

12. Extracting and inſpiſſating the juices of alimentary ſubſtances; as in making robs. Portable ſoup is an animal preparation of this kind.

13 Keeping in dry ſand.

The writer proceeds to examine which of theſe methods is beſt ſuited to each kind of vegetable matter.

Drying in ovens moderately heated, is a mode applicable to a great number of vegetables; as potatoes, turneps, carrots, legumes, apples, pears, plums, and other fruits. No method preſerves better all the qualities of the ſubſtance, is more eaſy to practiſe, or more efficacious. It deſerves to be generally recommended. *Drying by the circulation of warm air* is excellent for grains and farinaceous ſeeds, but inapplicable to other matters. *Salting with fermentation* may be uſed to all kinds of leaves and roots, and the preparation is a great preſervative from the ſcurvy. It might be made as general as drying in an oven. The other methods belong more particularly to the articles mentioned under them. That of inſpiſſating juices of fruits, &c. is a very effectual mode, but coſtly, and chiefly fitted for ſea ſtores. None of them can juſtly be accounted inſalubrious.

The Abbé then touches on the modes of preſerving *water* ſweet; particularly deſcribing an experiment tried in the French navy, of filling a caſk with water, adding both hands full of quick lime, letting it ſtand for five or ſix days, then pouring out the water and rincing the caſk, and afterwards putting in the water intended for the voyage. By this method water was kept perfectly ſweet during a ſix month's voyage to the iſles of France and Bourbon. The quick-lime was found to have made a thin coating round the inſide of the caſk.

Memoir on the infallible ſign of Death. By M. DURONDEAU.

AFTER enumerating the various opinions of authors relative to the ſigns of death, with the objections that have been made to them, the writer recurs to putrefaction as the only certain one. This opinion, which cauſed a popular outcry againſt Winſlow, from the danger the living would be expoſed to, if that ſign of death were always to be waited for, M. Durondeau endeavours to render unobjectionable, by diſtinguiſhing the two ſtates of incipient and complete putrefaction, and eſtabliſhing his proofs of death on the former, when no danger can ariſe to the living. The chymical products of theſe two ſtates, he alledges, are abſolutely different, acidity being that of the firſt, and alkaleſcence of the ſecond. In the firſt, the vapour that emanates is fixed air or aerial acid, joined with a certain cadaverous effluvium, which is ſufficiently manifeſt to the ſenſes. With this there is a glutinoſity of the humours, which exhale through the pores, and form a clamminеſs upon the ſurface of the body. From theſe two ſigns an incipient putrefaction may with perfect certainty be detected, and in conſequence the entire abolition of life. It is therefore the point at which the determination ſhould be made, and the body interred, without waiting for the ſecond ſtate in which the putridity becomes noxious. He diſtinguiſhes the putrid exhalations from living bodies in caſes of gangrene and ſphacelus, from thoſe of dead, the former being owing to the vital motion and heat, and ceaſing after death, ſo that there is no danger of miſtaking the two caſes. He does not think it neceſſary in all caſes rigorouſly to wait for interment till the ſigns of incipient putrefaction appear, but in thoſe in which no gradation of diſeaſe has preceded, as aſphyxies in general, hyſterics, apoplexies, external injuries, drowning, ſuffocating, and the like.

Continuation

Continuation of the Hiſtory of Belgic Foſſils. By the ABBE DE WITRY.

THE writer begins with noting ſome ſingularities of natural foſſils found in the Belgic Provinces. He firſt mentions appearances ariſing from terreſtrial fires, as metallic tinges of red and other colours, ſometimes changeable like the Iris, impreſſed upon the ſurface of calcarious ſtones. Theſe tinges are only ſuperficial; but the cryſtals found in the cavernous parts of ſtones are tinged throughout, ſo as to reſemble opals. The tinges of pebbles found in the currents of water are ſtill of a different nature; being diffuſed through a cruſt of enamel with which they are covered. In the breaks of calcarious ſtones are frequently met with ſpathous cryſtalliſations, ſometimes ſprinkled with blue cubical cryſtals, probably the indications of copper.

In ſome limeſtone quarries are found porous or pumiceous ſtones generally coated with a whitiſh enamel, which have been looked upon as proofs of ancient volcanos: but the writer ſuppoſes them the production of the artificial fires of lime-kilns; as he likewiſe does other remarkable foſſils that have been collected.

He next proceeds to accidental foſſils, ſuch as uncommon petrifications; and with reſpect to ſome of theſe, which repreſent ſome of the ſofteſt and moſt delicate parts of inſects, he cannot conceive that they are real converſions of ſuch parts into ſtone, but ſuppoſes that they are only the hardened impreſſions of them. The upper ſurface of an inſect becomes covered with a liquid earth, which dries and petrifies around it; the inſect itſelf in length of time entirely decays, leaving its incloſure in the form of an exact mould. This mould is afterwards accidentally filled with another earth incapable of uniting with it, which petrifying forms the figure of the inſect in relief. After this manner the writer explains ſome petrifactions of this kind, of which he annexes the figures. He ſubjoins deſcriptions and figures of a rare petrifaction which he ſuppoſes a *Fungites*, of an uncommon petrified plant, and a very large *Orthoceratites*.

Memoir of ſome extinct Volcanos in Germany. By the Prince de GALLITZIN.

THE noble writer, after beginning with ſome remarks on the want of agreement in the nomenclature of different mineralogiſts, eſpecially with regard to mixed earths and volcanic productions, proceeds to expreſs his ſurprize at the ſilence of naturaliſts reſpecting the extinct volcanos of Germany, which are extremely numerous, and open to common obſervation. Aſcending the Rhine, they commence beyond Bonn, and extend as far as Switzerland. They border both ſides of the Maine, and then enter Heſſe and the country of Fulda in a ſcattered manner, and terminate beyond Gottingen towards the Hartz foreſt. They are alſo found in Miſnia, Tranſylvania, &c. and ſeveral provinces of France are full of them. The prince, in his ſurvey of a few of thoſe in Germany, began with thoſe of Heſſe. The firſt he met with was that of *Grebenſtein* near Geiſmar. It yields a Baſaltic Lava. The mountain of *Carlſberg* near Caſſel is decidedly volcanic. The place of its crater is diſtinguiſhable. Near it, under a thin layer of vegetable mould, are porous Lavas, then heavy ones full of Schorls which give them a greeniſh hue. Immediately beneath begin the Baſaltic Lavas in great ſhapeleſs blocks. There are alſo priſmatic, ſquare and pentagonal Baſaltes. In the gravelly Lavas are often met with vitreſcent and calcarious ſtones perfectly preſerved, and uninjured by heat; whence the writer imagines that theſe

Lavas may have been only aſhes projected from the volcano, and afterwards agglutinated by the ſea-water, which, according to various proofs, once covered this mountain. Mr. De Luc ſuppoſes this, as well as all the other extinct volcanos of this country, to have been *ſubmarine*, but this notion is inconſiſtent with the appearance of the projection of large ſtones from it to a conſiderable diſtance.

The volcano of *Lang-gins*, near Marpurg, is remarkable for the ſmallneſs of its Baſaltes. It alſo yields Iceland agate or Obſidian ſtone, and Gallinaço ſtone.

The volcano of *Saxenhauſen* or *Sandhoff*, near Frankfort, is not conical, has no marks of crater, and little elevation. Its firſt ſtratum is powdered ſea-ſhells; its ſecond, the ſame mixed with a grey earth, followed by a grey limeſtone. Then begins either brown Traſs (Tufa) or Baſaltic Lava, containing black Schorls, Chryſolites, Zeolites, Chalcedonies, and tranſparent mammillated pieces of glaſs, ſome colourleſs, others with a hue of rainbow or mother-of-pearl. Globoſe and lamellated Selenites are alſo found in the firſt layer of ſand in this volcano. In the Lavas are often met with an iron-coloured matter, mammillated and lightly ſtriated when viewed laterally. Dr. Muller takes it for the *Platina del Pinto* of the Spaniards. Another unknown matter found in abandoned quarries, reſembling the yellow ſcoriæ taken from the ſides of the crater of Veſuvius, is ſuppoſed by Dr. Muller to be decompoſed or regenerating Zeolites.

In front of this volcano is that of *Bokenheim*, which is low, and has pits full of water. Among its Baſaltic Lavas are ſome oval ones in concentric ſtrata. The Baſaltes of the volcano of *Fornich* are priſmatic, forming a little giants' cauſeway open to the high road. The environs furniſh Traſs of three kinds, whitiſh, grey, and brown, which is a conſiderable article of commerce with Holland.

The volcano of *Unckel* on the Rhine, oppoſite to the village of that name, announces itſelf by two groups of Baſaltes appearing like organ-pipes above the bed of the river, and one on its edge. All thoſe touched by the water are white as chalk, and only the upper ones have preſerved the baſaltic hue. The mountain is not lofty, but has for ages been worked in quarries, and ſtill is a true magazine of Baſaltes. They are in groups, placed upon one another, their form various, four, five, and ſix-ſided in different manners: they are black, heavy, hard, ſtrike fire with ſteel, and are attracted by the magnet. They are covered by calcarious earth. The prince viſited no other volcanos. He obſerved, however, the mountain of *Schomberg* near Geiſmar, which is conical, and has a crater, but exhibits neither Lavas nor Scoriæ, but only an immenſe ſtream of red; and another of brown earth, which he conceives may be lavas decompoſed by time, or kinds of Pozzolane. Similar earths are found in many other places.

In none of theſe volcanos did he meet with pumices, ſcoriæ, nor ſulphur. Their Baſaltes a good deal reſemble each other, but with manifeſt differences. None of them are articulated, like thoſe of Antrim. They are all of a ſingle piece, varying in length, ſcarcely ever with more than ſix faces. It is impoſſible to fix the time when theſe volcanos became extinct, or to decide whether or no they have been ſubmarine. The bed upon which they are placed ſeemed to the writer univerſally granitic, but thoſe on the borders of the Rhine might poſſibly be quartoſe.

The paper concludes with a relation of a cylindrical piece of flint uſed by a peaſant for ſtriking fire, from which, on being broken, there came a ſcore of ſmall ſilver pieces current at Munſter in the beginning of the 14th century.

Memoir on ſome Mineral Subſtances which preſent the Phænomenon of Cryſtallization by Retreat. By M. De Launay.

BY *cryſtallization by retreat*, the writer means that produced by the drying of a ſubſtance formed the moiſt way, the effect of which is to diſunite the ſubſtance in priſmatic maſſes. What chiefly gave him this idea was a ſingular ore of iron found at Oſſegg, in the circle of Saatz, in Bohemia, of the kind known in French by the name of *Mine de fer limonenſe* (muddy ore of iron) in German by that of *Sump-fertz.* It undergoes a momentary effervescence from aquafortis; its colour is a deep reddiſh brown; its texture is a compoſition of priſmatic columns, pentagonal and hexagonal, cohering by their ſides, and perfectly reſembling in miniature baſaltic columns. Like theſe, too, ſome are jointed. Expoſed to the open air the roe undergoes a ſort of alteration, in which its priſms diſunite.

A ſpecimen of this ore which he particularly deſcribes, and which contained alſo ſome curved columns, reminded him of the figure of Fingal's cave in the iſle of Staffa; and gave him an idea how a vaſt maſs of columnar Baſaltes might, by the action of the air, undergo ſuch a diſunion of its columns as to produce a cavern of that kind. Theſe analogies in his opinion confirm the notion of thoſe who imagine that Baſaltes is not a true lava, but a matter originally volcanic, decompoſed and at length recompoſed in the moiſt way, or a muddy lava vomited by a volcano, the drying and ſhrinking of which has produced a cryſtallization by retreat, like that of the ore of Oſſegg.

The author carries ſtill further this idea, and ſuppoſes all ſtriated and filamentous ſubſtances of the mineral kingdom to have been the reſult of ſuch a cryſtallization. In ſupport of this, he lays down three principles. 1. That moſt ſtones and minerals have been formed the moiſt way: 2. That ſtriæ and filaments in minerals are true priſmatic cryſtals: 3. That from the external ſhapeleſs appearance of theſe minerals they could not have been cryſtallized the ordinary way. As ſomething analogous to the natural ſeparation of the priſms in the Oſſegg ore, he inſtances what are termed *unripe*, and *ripe*, *Aſbeſtus*, and ſuppoſes that in the latter a ſimilar ſeparation has taken place, but not in the former.

A Mineralogic Journey and Obſervations, from Bruſſels, by Wavre, to Cour-St.-Etienne. *By the Councellor* Franc. Xav. Burtin.

THE importance of the objects met with in this tour, is entirely local. A fine black chalk which might be made an article of commerce, and the exiſtence and value of a lead mine, are the principal topics.

Eſſays on ſome Precipitations of Metals and Semimetals. By M. De Beunie.

THE ſubject of metallic precipitations has hitherto been treated chiefly in the metallurgic way, and neither have the precipitants employed been numerous, nor has order been obſerved in the experiments. The intention of the preſent writer is to treat of them chymically, and eſpecially with a view to their utility in the arts of painting, dying, printing, and enamelling. Metallic colours are known to be the moſt durable of any, but their uſe is hitherto in many reſpects confined and imperfect.

CHAP. I. *On the Precipitation of Iron diſſolved in different Acids.*

This is an account of the reſult of experiments made with the ſolutions of iron in the three mineral and the acetous acids, with the addition of various precipitants. We ſhall give only the concluſions drawn from them.

1. Iron eaſily diſſolves in the four above-mentioned acids.

2. If wool be paſſed through any of theſe ſolutions in a ſaturated ſtate, it is dyed of a yellow more or leſs fixed; but the nitrous only gives a bright yellow, and the marine a deep gold-yellow.

3. Cotton alſo obtains a fixed yellow dye from theſe ſolutions; but that of the marine acid gives a colour preferable in beauty and durability to any uſed by the cotton printers.

4. Iron precipitated from any of theſe ſolutions by the Pruſſian alkali, (known by the name of ſuperphlogiſticated) yields a true Pruſſian blue, of different ſhades, but poſſibly not durable.

5. Pruſſian blue made from any acid is not ſoluble in the vitriolic acid. All the other precipitates of iron are.

6. Precipitates made by liver of ſulphur afford nothing intereſting to the painter or dyer.

7. Neither do thoſe made by arſenical liver of ſulphur.

8. Precipitates made by fixed alkali afford very uſeful colours, particularly from the ſolution in the nitrous acid, which are of a fine yellow. Thoſe with the marine acid are of a good browniſh yellow. As dyes, however, they are of no extraordinary utility.

9. Precipitates with the volatile alkali differ little from thoſe of the fixed.

10. Precipitates by cauſtic alkali from all the acids, except the acetous, yield the fineſt gold-yellow that can be ſeen, which would be peculiarly uſeful to painters. It cannot be imitated by any mixture.

11. Infuſion of galls precipitates iron from all ſolutions in a black powder; the deepeſt and ſofteſt is that from the marine ſolution. It would be very uſeful to painters. The vitriolic ſolution with galls dyes wool of a laſting black, but gives only a yellow to cotton. The marine does the ſame. The acetous gives a fixed black to cotton, but a fugitive one to wool. Paper being, like cotton, a vegetable matter, ink to write upon it is therefore more durable and deeper if made with an acetous ſolution of iron, than with a vitriolic.

CHAP. II. *On the Precipitation of Copper diſſolved in different Acids.*

Vitriolated copper precipitated from its ſolution by Pruſſian alkali is of a dirty blue, which is changed to brown by vitriolic acid. Precipitated by liver of ſulphur, it imparts a black to cotton, at firſt light, but which becomes deeper on waſhing. The precipitate by infuſion of galls gives woollen cloth a yellowiſh cheſnut colour which ſtands, and cotton a deep tawny, which is alſo durable.

A ſolution in *nitrous acid* precipitated by liver of ſulphur dyes woollen cloth of a good olive, which ſtands; precipitated by arſenical liver of ſulphur it gives woollen a deep olive, alſo durable. The colours on cotton are fixed, but dull. The latter precipitate forms a very deep, ſoft, black powder, that would be uſeful as a pigment. The precipitation by cauſtic alkali dyes wool and cotton of a blue, changing to green on waſhing, which is fixed. That by infuſion of galls dyes wool and cotton a durable fillemot.

The precipitates from ſolution of copper in *marine* acid all give fugitive colours, except that with cauſtic alkali, which dyes woollen of a fine blue changing to deep fixed green on waſhing; and that with infuſion of galls, which dyes cotton of a fixed brown.

The ſolution in *vinegar* precipitated with arſenical liver of ſulphur dyes woollen of a very fixed yellowiſh brown. Precipitated with infuſion of galls, it gives a fixed fillemot to cotton.

CHAP. III. *On the Precipitation of Tin.*

Tin diſſolved in the *vitriolic* acid and precipitated by the Pruſſian alkali forms a Pruſſian blue much brighter than the common. It dyes woollen cloth of a bright royal blue which ſtands the ſun and air, but not ſoap. The precipitate with arſenical liver of ſulphur is of a fine jonquil-yellow, which it imparts to wool and cotton. That with fixed alkali is firſt of a ſullied white, but afterwards of a pure white, much ſuperior to ceruſſe. That with infuſion of galls dyes wool and cotton of a fawn-colour. The *marine* acid ſolution, with arſenical liver of ſulphur gives a very bright and fixed gold-yellow to wool and cotton. With fixed alkali, the precipitate is a very fine white calx. In the reflexions on theſe experiments the author expreſſes his ſurpriſe that Meſſ. Monnet and Morveau found that tin precipitated by the Pruſſian alkali gave a ſallow colour, whereas he procured blue or bluiſh precipitates from all the acids. He afterwards obſerves, that moſt vitriolic acid contains ſome iron, and that on adding iron to the ſolution of tin in the marine acid, the precipitate was a very full Pruſſian blue. It may further be remarked, that the Pruſſian alkali uſed by this writer is made by adding to oil of tartar, Pruſſian blue in powder, till it no longer loſes its colour, whence this alkali probably contains iron in ſolution.

CHAP. IV. *On the Precipitation of Lead.*

The only ſolution of lead employed, was made by diluted *nitrous* acid. This, precipitated by arſenical liver of ſulphur, formed a red orange powder, more beautiful than red lead, which might be uſed as a pigment. None of the other reſults are intereſting.

Tables of Monies, Weights and Meaſures, Ancient and Modern, of different Nations, with their Valuation; extracted from Authors who have treated theſe Matters with the greateſt Exactneſs, and preceded by a Memoir on their Nature, Authority and Uſe. By the ABBE MANN.

THE memoir gives a ſhort account of ſome attempts to eſtabliſh a longitudinal natural, invariable, and univerſal meaſure for all nations. The firſt noticed is that of Greaves, who propoſed a ſtandard taken from a tomb of a ſingle piece of porphyry,

phyry, and the chamber containing it, in the largeſt of the pyramids of Egypt. Mouton, an aſtronomer at Lyons, propoſed a rod of which 600,000 would make a degree in latitude, and he remarked the number of vibrations that a pendulum of this length would make in 30 minutes. The Abbé Picard made a ſimilar propoſition. From that time the principle of a ſtandard meaſure was ſought in the pendulum. Condamine propoſed that of an equinoctial or equatorial pendulum ſwinging ſeconds. The Royal Society of London, and the Society of Arts, occupied themſelves with the ſame object, and the latter in 1777 and 1781 offered a prize for a ſtandard natural and univerſal meaſure. The neareſt approach to it was that of Mr. Thomas Hatton, Clockmaker, in London, whoſe method was to take the difference between two centres of ſuſpenſion, one fixed, the other moveable, on the ſame pendulum. After all, the eſtabliſhment of an uniformity of weights and meaſures is probably impracticable, whence authentic tables of thoſe of different countries compared with each other muſt be of eſſential utility.

The Abbé then proceeds to enumerate the tables he is to give, with their nature and uſe. As theſe are for the moſt part only a compilation, and incapable of abridgement, we ſhall content ourſelves with copying two or three, which we conceive will be moſt acceptable to our readers.

The following is a compariſon of the *As Troy* of Holland and the Low Countries, with the weights of England, France and the Empire. It is to be premiſed, that gold, ſilver, and coins are weighed by the *marc troy*. One *marc troy* contains 8 *ounces*, 160 *eſterlins*, and 5120 *as's*: 32 *as's* = 1 *eſterlin*; 20 *eſterlins* = 1 *ounce*; 8 *ounces* = 1 *marc*; 2 *marcs* = 1 lb. *troy*.

10,000 *as's troy* of Holland and the Auſtrian Low Countries are equal to,	7,413	grains, Engliſh.
	7,723	grains, Apothecaries weight.
	8,947	eſchen, or as's of Cologn.
	9,033	grains, French.
	134,736	richtpfennings-theile of the Empire.

10,000	grains, Engliſh, make	13,489	as's troy of Holland and the Auſtrian Low Countries.
	grains, Apothecaries	12,947	
	eſchen of Germany	11,176	
	grains, French	11,070	
	richtpfennings-theile	742	

TABLE II.

The principal real gold monies of different nations; their weight, alloy, and value in Troy as's of Holland in fine gold.

Note. The degree of alloy is expreſſed by the number of carats and grains of pure gold in the marc, 1 marc of gold contains 24 carats, 1 carat contains 12 grains, 1 marc = 288 grains.

Names of Pieces.	Entire weight in as's Tr.	Degree of alloy. carats, grs.	As's of fine gold.
Ducat of Holland	72,6	23.7	71,33¼
——— of Hamburg	72,6	23.6	71,08
——— of the Empire, according to the Imperial regulation	72,6	23.8	71,5
——— of Kremnitz	72,6	23.9	71,8
Engliſh Guinea, by the law	174,5	22.0	160
——————— by cuſtom	174,5	21.10	158,87
French Louis d'or to 1786, by the law	170,0	22.0	155,8
——————————— by cuſtom	169,3	21.8¼	153,2
Spaniſh Doublon, or Piſtole ſince 1772, by law	140,6	22.0	128,0
—————————————— before 1772	141	21.8	127,2
Dobra of Portugal ſince 1722	597,5	22.0	547,7
Moidore or Liſbonine	224	22.0	205,3
Zeechin of Rome	72,2	23.6	70,7
Zeechin of Genoa (that of Florence is very nearly the ſame)	72,7	23.10½	72,3
Zeechin of Venice	72,8	23.10½	72,4
Double ſovereign of the Auſtrian Low Countries	231,8	22.0¾	213,15
Gold Florin of the Empire, or Gulden of the Rhine,	71,5	19.0	56,6
Piſtole of Geneva, 1752	118	22.0	108,2
Gold Frederick of Pruſſia	138,8	21.9	125,9
New Ducat of Denmark of two Rixthalers, ſince 1757	65	21.2	57,4
Gold Adolphus of Sweden and Pomerania	138,8	15.4	88,6
Imperial of Ruſſia of ten rubles, ſince 1755	344,5	22.0	315,7
Sultanin of Turkey, 1723	72,75	20.0	60,6
Rupee of the Mogul Empire	231	23.9	228,6
Pagoda of the Engliſh Company at Madras	71,2	20.8⅖	61,4

TABLE X.

Meaſures of diſtance of different nations, ancient and modern, compared with a degree of latitude; and their reſpective value in French toiſes.

General Meaſures.	Compariſon of equality.	Value in Fr. toiſes.
Degree of latitude under the equator, meaſured in Peru	*1	56753
Degree under latitude 45° (*Mem. Acad. Par.* 1758)	1	57028
Degree under lat. of Paris, 49°	1	57069
Degree between lat. 51 and 52	1	57100
Degree under the polar circle, in Lapland	1	57422
Geographic league of 4000 geomet. paces	15	3802
Geographic mile of 1000 geomet. paces	60	950½
Common marine league	20	2053½
Oceanic marine mile	60	951⅙
Mediterranean marine mile	75	760
Ancient Meaſures.		
Egyptian ſtadium according to Herodotus; of 600 Egyptian feet	670⅔	85
Egyptian paraſang, or little ſchœnus of the Delta = 30 ſtadia	22⅓	2550
Common Egyptian ſchœnus of two paraſangs	11⅙	5100
Great ſchœnus of four paraſangs	5$\frac{7}{12}$	10,200
Paraſang of the moſt ancient Perſians, equal to the Egyptian of 30 ſtadia	22⅓	2550
Perſian paraſang in the time of the Roman Empire	15	3800
Armenian paraſang = 40 Egyptian ſtadia	16¾	3400
Egyptian ſtadium according to Freret and Le Roy	498⅛	114,13
Grecian ſtadium according to Ariſtotle, Xenophon, &c.	1111	51,305
Ancient Roman ſtadium	600	94,693
Hebrew mile, according to Epiphanius	100	570
Roman mile, according to Pliny, of 1000 paces and 5000 feet	75	760
Roman mile of Strabo, according to Caſſini	74½	766
Roman mile, according to D'anville	75½	755½
Roman mile, according to Pauſton	71,9	793,6
Ancient Spaniſh and Gallic mile of 1500 paces	50	1141½
Raſte of the ancient Germans	25	2283

Modern Meaſures.	Compariſon of equality.	Value in Fr. toiſes.
Common or middle French league	25	2282$\frac{3}{4}$
Engliſh mile of 5280 feet Engliſh (lat. 51½)	69,149	825,75
French and Engliſh marine leagues	20	2850
Italian mile	60	950
Modern Roman mile, according to Boſcovich	74$\frac{3}{5}$	764
Spaniſh leagues	17½	3257
Dutch and Spaniſh marine leagues	15	3800
Common league of the Low Countries	22	2600
Common league of Germany	15	3800
Common league of Hungary	12	4755
League of Poland	20	2853$\frac{3}{5}$
League of Pruſſia	16	3562
League of Sweden	12	4755
Werſt of Ruſſia	90	634$\frac{4}{9}$
Common mile of Turkey	60	950
Modern mile of Lower Egypt	110	518
Paraſang of modern Perſia	18$\frac{7}{9}$	3036$\frac{7}{9}$
Modern mile of Arabia	56	1017$\frac{6}{7}$
Coſs of the Mogul Empire	40	1425
Coſs of Camboya and Guzarat	30	1900
Mile of the Eaſt Indies	100	568
Li of China, according to De la Lande	193	295
——— according to the Encyclopedia of Yverdun	250	228
Pu of China = 10 lis = $\frac{1}{20}$ of a degree, according to Varenius	20	2800
Uchan of China, or one day's journey = 10 pu	2	28000
League of Japan	25	2283

Theſe tables, which are 14 in number, but ſome of the numbers conſiſting of two or three ſeparate ones, are followed by an Appendix concerning the *nature of money and of alloy.* In this the Abbé follows the opinion of thoſe who contend that the value of gold and ſilver is not an imaginary one, founded on general conſent, but a real one, referring to their uſe as metals, and to other intrinſic qualities rendering them proper to be an univerſal ſtandard in commerce. He treats on the different ſtandards and modes of reckoning the proportion of pure metal and alloy throughout Europe, and the relative value of gold and ſilver in their coins. A table of this laſt we ſhall copy.

One marc of fine gold.			Marcs of fine ſilver.
In France is equivalent	to	14$\frac{151}{288}$	
In England	to	15$\frac{158}{690}$	
In Holland	to	14$\frac{21}{47}$	
In Spain	to	14$\frac{416}{484}$	
In Portugal	to	15$\frac{463}{592}$	

The memoir concludes with a bibliographic account of the principal authors ancient and modern, who have treated on monies, weights and meaſures, including edicts, tables, &c.

Syſtematic Diſtribution of the Productions of the Mineral Kingdom. By M. De Launay.

MINERALS *or* Fossils are firſt divided into four claſſes, of which the firſt comprehends *earthy ſubſtances*; the ſecond, *ſaline ſubſtances*; the third, *mineral ſubſtances with a phlogiſtic baſe*; the fourth, *metallic ſubſtances.*

Class I. Earthy Substances.

Simple, or primitive earths, are of five kinds: 1. *Siliceous earth*: 2. *Argillaceous earth, or earth of alum*: 3. *Muriatic earth, or magneſia*: 4. *Ponderous earth, or barytes*: 5. *Calcareous earth.*

Compound Earths *and* Stones.

I. *Combinations of Siliceous Earth.*

1. Siliceous earth united to a ſmall portion of argillaceous and calcareous earth. *Quartz.*

2. Siliceous earth intimately mixed with $\frac{1}{4}$ to $\frac{1}{3}$ its weight of argillaceous earth, and with $\frac{1}{11}$ to $\frac{1}{12}$ its weight of calcareous earth. *Petroſilex. Hornſtein of the Germans.*

3. Siliceous earth intimately mixed, and in part combined with about $\frac{1}{4}$ its weight of argillaceous earth, and $\frac{1}{40}$ of calcareous earth. *Silex. Flint. Feüerſtein* of the Germans. *Agate. Jade.*

4. Siliceous earth united to argillaceous earth. *Calcedony. Opal. Pitch-ſtone.*

5. Siliceous earth intimately mixed with about $\frac{1}{3}$ its weight of argill, and $\frac{1}{6}$ or $\frac{1}{7}$ of calx of iron. *Jaſper.*

6. Siliceous earth intimately mixed and partly united with 0,209 its weight of argillaceous earth, 0,164 of ponderous earth, and 0,12 of magneſia. *Feldſpath.*

7. Siliceous earth united to calcareous earth, magneſia, iron, and copper. *Chryſopraſium.*

8. Siliceous earth mixed with calcareous earth, gypſum, ſparry acid, and iron. *Lapis lazuli.*

9. Siliceous earth united in different proportions to argillaceous and calcareous earth and water. *Zeolite.*

10. Siliceous earth united to argillaceous earth, magneſia, calcareous earth, and iron. *Trapp. Baſaltes. Hornſtone. Schorl.*

11. Siliceous earth imperfectly united with 1,05 to 1,47, its weight of argillaceous earth, with 0,3 to 0,4 of aerated calcareous earth, and with 0,15 to 0,243 of iron. *Tourmaline.*

12. Siliceous earth united to argillaceous earth, calcareous earth, and deplogiſticated iron in the proportion of $\frac{2}{100}$ to $\frac{20}{100}$. *Garnet.*

13. Siliceous earth united perfectly with argillaceous earth from once to thrice its weight, with aerated calcareous earth from $\frac{1}{6}$ to equal its weight, and with iron from $\frac{1}{10}$ to equal its weight. *Ruby. Hyacinth. Topaz. Sapphire. Emerald.*

Appendix. Stony ſubſtance the principles of which are not yet well known, and compoſed for the greateſt part of an inflammable matter. *Diamond.*

II. *Combinations of Argillaceous Earth.*

1. Argillaceous earth combined with aerial acid, and mixed with quartz or ſilex in duſt, with a ſmall quantity of water, and commonly with iron. *Porcelain earth. Glaiſe*, or *Pipe-clay. Bole. Argill. Argill ſurcharged with iron*, or *Argill Mineral.*

2. Argillaceous earth intimately mixed with 1,77 its weight of ſiliceous earth, 0,3 of magneſia, 0,15 of calcareous earth, each ſlightly aerated, and near 0,54 of iron, beſides a ſlight mixture of mineral oil. *Purple blueiſh Slate.*

3. Argillaceous earth mixed with a variable quantity of pyrites, a little magneſia, and calcareous earth. *Pyritous Schiſtus.*

4. Argillaceous earth mixed with ſiliceous and calcareous earths. *Clayey Marl.*

5. Argillaceous earth mixed with much ſiliceous earth, a little magneſia, aerated calcareous earth, dephlogiſticated iron, and water. *Fuller's Earth.*

6. Argillaceous earth mixed with ſiliceous earth and magneſia. *Terra lemnia.*

7. Argillaceous earth united to much ſiliceous earth, magneſia, and more or leſs of iron. *Mica.*

III. *Combinations of Muriatic Earth.*

1. Muriatic earth or magneſia mixed with an equal quantity of ſiliceous earth. *Spuma Maris.*

2. Magneſia combined with ſiliceous and argillaceous earths. *Talc. Steatites. Lapis ollaris.*

3. Pure magneſia, combined with a little more than its weight of ſiliceous earth, about $\frac{1}{3}$ of argillaceous earth, near $\frac{1}{3}$ of water, and from $\frac{1}{10}$ to $\frac{2}{10}$ of iron. *Serpentine.*

4. Aerated magneſia, combined with ſiliceous earth, calcareous earth, and a ſmall portion of argillaceous earth, and iron. *Aſbeſtos.*

5. Aerated magneſia, combined with ſiliceous earth, aerated calcareous earth, ponderous and argillaceous earths, and iron. *Amianthus.*

IV. *Combinations of Ponderous Earth.*

1. Ponderous earth combined with aerial acid. *Aerated Baroſelenite.*

2. Heavy earth combined with vitriolic acid. *Hoary Spar. Marmor metallicum of Cronſtedt.*

3. Heavy vitriolated earth, penetrated by petroleum, and rendered impure by gypſum, alum, and ſiliceous earth. *Liver ſtone.*

V. *Combinations of Calcareous Earth.*

1. Calcareous earth combined with the aerial acid. *Chalk. Limeſtone. Marble. Calcareous Stalactites. Calcareous Spar.*

2. Aerated calcareous earth, mixed with a notable portion of ſiliceous earth. *Starry Spar. Sterne Spath* or *Stern Schorl* of the Germans.

3. Aerated calcareous earth, mixed with argillaceous and ſiliceous earths. *Calcareous Marl.*

4. Aerated calcareous earth mixed with a notable quantity of magneſia. *Compound Spar. Kreutzenwald ſtone.*

5. Calcareous earth combined with ſparry acid. *Fluor,* or *Fuſible Spar.*

6. Calcareous earth ſaturated with Tungſten acid. *Tungſten.*

7. Aerated calcareous earth, more or leſs impregnated with petroleum. *Swine-ſtone,* or *Stink-ſtone.*

ROCKS.

Theſe are the reſult of certain mixtures of various ſtones; but the union is ſometimes ſuch, that the ſtones of the ſame rock ſeem as it were melted together, and to have been produced at the ſame time; whereas other rocks are viſibly only fragments of ſtone or ſand united by a ſtony gluten. Of theſe, the firſt may be called *primitive*, the laſt, *ſecondary*.

I. *Primitive Rocks.*

1. Rocks with a baſe of quartz.
2. Rocks with a baſe of petroſilex.
3. Rocks with a baſe of jade.
4. Rocks with a baſe of jaſper.
5. Rocks with a baſe of feldſpath.
6. Rocks with a baſe of trapp.
7. Rocks with a baſe of baſaltes.
8. Rocks with a baſe of hornſtone or hornblend.
9. Rocks with a baſe of ſchorl.
10. Rocks with a baſe of granit.
11. Rocks with a baſe of hardened clay.
12. Rocks with a baſe of ſchiſtus.
13. Rocks with a baſe of ſteinmark.
14. Rocks with a baſe of mica.
15. Rocks with a baſe of talc.
16. Rocks with a baſe of ſteatites.
17. Rocks with a baſe of lapis ollaris.
18. Rocks with a baſe of ſerpentine.
19. Rocks with a baſe of aſbeſtus.
20. Rocks with a baſe of hoary ſpar.
21. Rocks with a baſe of limeſtone.
22. Rocks with a baſe of marble.
23. Rocks with a baſe of calcareous ſpar.
24. Rocks with a baſe of ſtony calcareous marl.
25. Gypſeous rocks.

II. *Secondary Rocks.*

1. Breccias, or fragments of ſtone conglutinated.
2. Sand-ſtones, or particles of ſand conglutinated.
   - By an argillaceous gluten.
   - By a calcareous gluten.
   - By a marly gluten.
   - By a ferruginous gluten.

CLASS II. *Saline Subſtances.*

Primitive Salts are *Acids* and *Alkalis.*

The *acids* of the mineral kingdom are the *vitriolic*, the *muriatic*, the *ſparry*, the *arſenical*, the *molybdenic*, the *tungſten*, the *phoſphoric*, the *ſedative.*

I. *Combinations of the Vitriolic Acid.*

1. Vitriolic acid combined with argillaceous earth. *Alum.*
Native alum. Alum mixed with ſome other ſubſtance. Alum ores. Aluminous earth. Sulphureous argill. Pyritous argill. Aluminous ſchiſtus. Volcanic aluminous ore.

2. Vitriolic acid combined with magneſia. *Vitriolated Magneſia*, or *Bitter Salt.*
3. Vitriolic acid combined with calcareous earth. *Gypſum.*
4. Vitriolic acid combined with mineral alkali. *Glauber's Salt.*
5. Vitriolic acid combined with zinc. *Vitriol of Zinc*, or *White Vitriol.*
   Vitriol of Zinc mixed with ſome other ſubſtance.
6. Vitriolic acid combined with cobalt. *Vitriol of Cobalt.*
7. Vitriolic acid combined with nickel. *Vitriol of Nickel.*
8. Vitriolic acid combined with iron. *Vitriol of Iron. Martial* or *Green Vitriol.*
   Native Vitriol of Iron.
   ———————————— *mixed with ſome other ſubſtance.*
   Vitriol of Iron mixed with Vitriol of Nickel.
   Ores of Vitriol of Iron.
   Lapis Atramentarius.
   Martial Pyrites.
9. Vitriolic acid combined with copper. *Vitriol of Copper. Blue Vitriol.*
   Vitriol of copper mixed with ſome other ſubſtance.

II. *Combinations of the Muriatic Acid.*

1. Muriatic acid combined with fixed mineral alkali. *Common* or *Culinary Salt.*
2. Muriatic acid ſaturated by volatile mineral alkali. *Sal Ammoniac. Alkali volatile ſalitum* Bergm.
3. Muriatic acid combined with magneſia. *Muriatic magneſia. Magneſia ſalitum*, Bergm.
4. Muriatic acid combined with calcareous earth.
   Muriatic Lime. Calx ſalita, Bergm.

III. *Combinations of the Sedative Acid.*

Sedative acid combined with mineral alkali. *Borax.*

CLASS III. MINERAL SUBSTANCES WITH A BASE OF PHLOGISTON.

COMBINATIONS OF PHLOGISTON.

1. Phlogiſton ſaturated with the vitriolic acid. *Sulphur.*
   Native Sulphur.
   Sulphur mixed with other ſubſtances.
2. Phlogiſton united with the vitriolic and the Molybdenic acids. *Molybdena. Waſſerbley* of the Germans.
3. Phlogiſton ſaturated with aerial acid. *Plumbago. Reisſbley* of the Germans.

CLASS IV. METALLIC SUBSTANCES.

Theſe are found in three ſtates, *native*, *calciform*, and *mineraliſed.*

MANGANESE. Always *calciform.*

ANTIMONY. *Native. Calciform. Mineraliſed.*

1. Mineraliſed by Sulphur.
2. ———————by Sulphur and Arſenic.

Zinc. *Calciform.*
1. Pure calx of zinc. *Spar of Zinc. Vitreous ore of Zinc.*
2. Calx of zinc mixed with argill and iron, and ſometimes with ſiliceous earth. *Calamine.*

Mineraliſed.

Zinc and iron mineraliſed by ſulphur. *Blend.*

Cobalt. *Calciform.*
1. Black calx of Cobalt.
2. ———————— mixed with other ſubſtances.
3. Red calx of Cobalt.
4. ———————— mixed with other ſubſtances.

Mineraliſed.
1. Cobalt mineraliſed by arſenic with a little iron. *Grey Cobalt Ore.*
2. Cobalt mineraliſed by iron and ſulphur. *White Cobalt Ore.*
3. Cobalt mineraliſed by ſulphur and arſenic, with iron. *White Arſenical Cobalt Ore.*

Arsenic. *Native*, united with iron.

Calciform.

Calx of arſenic mixed with other ſubſtances.

Mineraliſed by ſulphur. *Orpiment. Realgar.*

Nickel. *Native. Calciform. Mineraliſed.*

Mineraliſed by ſulphur and arſenic, with cobalt and iron. *Kupfernickel.*

Bismuth. *Native. Calciform. Mineraliſed.*
1. Biſmuth mineraliſed by ſulphur. *Sulphureous Ore of Biſmuth.*
2. Biſmuth with iron, mineraliſed by ſulphur. *Martial ore of Biſmuth.*

Tin. *Native. Calciform.*

Tin ſpar.

Vitreous calciform tin.

Mineraliſed.

Tin mineraliſed by ſulphur. *Sulphureous ore of Tin.*

Iron. *Calciform.*
1. Black iron ore. *Stahlertz.*
2. Loadſtone.
3. Black micaceous ore of iron. *Eiſenman.*
4. Sparry or white iron ore.
5. Torſten.
6. Cryſtalliſed iron ore of the iſle of Elba.
7. Specular ore of iron.
8. Hæmatites. *Glaſkopf.*
9. Red micaceous iron ore. *Eiſenrahm.*
10. Martial ochre.
11. Muddy iron ore.
12. Emery.
13. Wolfram.
14. Native Pruſſian blue.

Mineraliſed.
1. Iron mineraliſed by ſulphur. *Martial pyrites. Yellow martial pyrites. Brown martial pyrites.*
2. Iron and arſenic mineralized by ſulphur. *Arſenical pyrites.*
3. Iron mineraliſed by arſenic. *Miſpickel.*

COPPER. *Native. Calciform.*
1. Red calx of copper, tranſparent and vitreous, and opake.
2. Blue calx of copper.
3. Green calx of copper.
4. Green calx of copper mixed with clay and combined with muriatic acid.

Mineraliſed.
1. Copper mineraliſed by ſulphur. *Vitreous ore of copper.*
2. Copper mineraliſed by ſulphur with $\frac{20}{100}$ to $\frac{30}{100}$ of iron. *Azure copper ore.*
3. Copper with much iron, and mineraliſed by ſulphur. *Cupreous Pyrites*, or *Yellow copper ore.*
   The ſame decompoſed. *Brown* and *Black cupreous ochre.*
4. Copper with iron and arſenic, and mineraliſed by ſulphur. *Grey copper ore. Fahlertzt.*
5. Copper with zinc and iron, and mineraliſed by ſulphur. *Brown copper ore.*
6. Copper with antimony and arſenic, and mineraliſed by ſulphur. *Antimonial copper ore.*

Append. *Argillaceous copper ore. Inflammable copper ore.*

LEAD. *Calciform.*
1. Earthy calx of lead.
2. Sparry calx of lead.

Mineraliſed.
1. Lead with ſilver and a little iron, and mineraliſed by ſulphur. *Galena.*
2. Lead mineraliſed by ſulphur, with ſilver and regulus of antimony. *Antimonial ore of lead.*
3. Lead with ſilver, and mineraliſed by ſulphur and arſenic. *Siberian red ore of lead.*

MERCURY. *Native. United to ſilver. Calciform. Mineraliſed.*
1. Mercury mineraliſed by vitriolic and muriatic acids. *Horny ore of Mercury.*
2. Mercury mineraliſed by ſulphur. *Cinnabar.*
3. Mercury mineraliſed by ſulphur, and combined with Bolar earth. *Argillous cinnabar.*
4. Mercury mineraliſed by ſulphur with copper.

SILVER. *Native. Mineraliſed.*
1. Silver mineraliſed by the vitriolic and muriatic acids. *Horney ore of ſilver.*
2. Silver mineraliſed by ſulphur. *Vitreous ore of ſilver.*
3. Silver mineraliſed by ſulphur and arſenic. *Red ſilver ore.*
4. Silver mineraliſed by ſulphur, with a very ſmall portion of arſenic and iron. *Black iron ore.*
5. Silver mineraliſed by arſenic and ſulphur with a ſmall portion of copper, and ſtill leſs of iron. *White ſilver ore.*
6. Silver mineraliſed by arſenic and ſulphur, with a large portion of copper, and ſome iron. *Grey ſilver ore.*

7. Silver mineraliſed by arſenic and ſulphur, with copper, iron, and regulus of antimony. *Brown ſilver ore* of Kirwan.
8. Silver mineraliſed by ſulphur and arſenic, with iron and regulus of antimony. *Plumous* or *antimonial ſilver ore.*
9. Silver mineraliſed by ſulphur and arſenic, with cobalt and iron. *Cobaltic ſilver ore.*
10. Silver mineraliſed by ſulphur with regulus of antimony and barytes. *Butyraceous ſilver ore* of Kirwan.

Uncertain mineraliſations. *Gooſedung ſilver ore.* *Foliated ſilver ore.*

Platina. *Native.*

Gold. *Native.*

1. Gold, native, viſible, and adherent to ſome matrix.
2. Gold, native, viſible, ſeparated from a matrix.
3. Gold, native, inviſibly mingled with other ſubſtances.

First Appendix to the Productions of the Mineral Kingdom.

Volcanic Subſtances.

1. Lavas.
2. Volcanic aſhes.
3. Pumice ſtone.
4. Volcanic glaſs.

Second Appendix to the Productions of the Mineral Kingdom.

Accidental Foſſils.

I. Of the Vegetable Kingdom.

Plants. Woods. Fruits. Bitumens. Turf.

II. Of the Animal Kingdom.

Human bones. Spoils of Quadrupeds. Parts of foſſil Birds. Parts of foſſil Amphibia. Petrifactions and Impreſſions of Fiſhes. Impreſſions of Inſects. Foſſil Cruſtacea. Foſſil Shells. Zoophytes or Foſſil Polypes.

Meteorological Obſervations for the Years 1783. 1784. 1785. 1786. 1787.

Theſe we ſhall paſs over, as no longer intereſting to our readers.

Obſervation

Obſervation of a Total Eclipſe of the Moon on the 10*th of September* 1783, *taken at Bruſſels, by the* Abbe Chevalier.

SEVERAL days before the 10th. the weather had been rainy, foggy, or clouded; on the 10th, at five in the evening there was a ſtorm, with rain, and it rained at eight, at nine the ſky was clear, and the time in general favourable for the immerſion of the ſpots.

	h. m. s.
The penumbra was perceived by the naked eye at but was not obſerved through the teleſcope.	9..48..0
It was perceived through the teleſcope	9..54..0
Penumbra very ſtrong	9..58..30
Commencement of the eclipſe doubtful	10.. 0..50
Certain	10.. 1..30
Grimaldus touches the umbra	10.. 3..47
Grimaldus wholly in the umbra	10.. 4..50
The umbra touches Galileo	10.. 6..20
Kepler	10.. 9..30
Ariſtarchus	10.. 8..20
Copernicus	10..18..8
Copernicus wholly in the umbra	10..19..20
The umbra touches Mare Nubium	10..26..20
Mare Nubium wholly in the umbra	10..28..28
The umbra touches Tycho	10..30..20
Tycho wholly in the umbra	10..31..48
The umbra touches Mare Nectaris	10..42..10
Mare Nectaris wholly in the umbra	10..47..2
The umbra touches Mare Criſium	10..49..30
Mare Criſium wholly in the umbra	10..54..2
Total immerſion rather doubtful	10..59..30
Certain	11.. 0..25

Though the umbra was deep and ſtrong, the diſc was ſeen during the whole of the eclipſe. Its colour was a darkiſh red, and the ſpots were not ſo eaſily diſtinguiſhed, as in the eclipſe laſt March, but ſome parts appeared clearer than others. The weſtern edge was clearer than the reſt of the diſc, and afterwards the eaſtern, whoſe clearneſs gradually increaſed to the time of emerſion.

Emerſion rather doubtful	12..41..55
certain	12..42..5
Grimaldus emerges from the umbra	12..44..15
Galileo emerges from the umbra	12..45..50

The emerſion of ſeveral other ſpots were perceived, but the time was not noticed with ſufficient preciſion. A fog beginning at midnight became ſo thick at one, that the limits of the umbra could not be aſcertained. The end of the eclipſe could not on that account be preciſely aſcertained, but but we may be aſſured that it was over by 1*h*..45′.

Tranſit of Mercury over the Sun, on the 3d of May, 1786, *obſerved at the Royal College, Louvain, by Mr.* Pigott, *F. R. S. &c.*

BY Mr. Pigott's obſervation, Mercury's centre quitted the ſun's diſc at 20*h*..47′.. 28″or 29″, by Mr. Geaurat's, at Paris, at 9*h*..45′. The difference of meridians = 9′..37″, which being taken from 20*h*..47′..28″½, gives the time of quitting at Paris 20*h*..37′..51″½, and the error of the tables amounts to 52′..51″½.

For the encouragement of young aſtronomers, who are not provided with excellent inſtruments, Mr. Pigott relates the following circumſtances. In his obſervatory at Greenwich, he has a fine paſſage inſtrument with five threads perpendicular to a ſixth or horizontal thread, with which he has often obſerved merely from curioſity, the paſſage of the ſun and moon's centres by the middle threads, and rarely found a difference of 2″ from the reſult given by the paſſage of the two edges by the five other threads. The difficulty of determining the departure of Mercury's centre, ſeemed from the ſmallneſs of its diameter, and other reaſons very great, but he eſtimated it as may be ſeen from the table, within two ſeconds and a half, as it would have been derived from the contact of the edges and departure. So the diameter of Mercury appeared to be $\frac{1}{60}$ of the ſun's ſemidiameter, by a compariſon of Mercury, with the ſpot *a*, which he judged to be three times as large as Mercury, and $\frac{1}{20}$ of the ſun's ſemidiameter. This quantity is certainly too great, but theſe circumſtances merit the attention of thoſe for whom he has made remarks.

May 3d. the ſpots were very numerous, *a* was the largeſt. Its ſize is thus computed. A = ſun's parallax B = diameter of the earth C = ſpot's apparent diameter, then $\frac{B \times C}{2\ A}$ = ſpot's real diameter, from which if we ſuppoſe it to be ſpherical, the ſolid contents are eaſily found.

True time. h. ′ ″	
18..32..30	Flying clouds, Mercury ill defined
19..13..30	Spot *a* appeared three times greater than Mercury, ſpot *b* twice as great
19..16..30	*a* perpendicular to the ſun's horizontal diameter, cuts Mercury and the ſpot *b*
19..27..30	*a* ſimilar perpendicular from Mercury is equally diſtant from *a* and *b*
19..34..30	The perpendicular from Mercury, cuts the centre of the ſpot *a*
19..42..30	The perpendicular is beyond the ſpot *a*
19..45..30	The perpendicular at ſome diſtance from *a*
20..12..30	The perpendicular equally diſtant from *a*, and *c*
20..27..30	Mercury of a deep black, round and well defined
20..45..41	The edges of Mercury, and the ſun in contact, perhaps ſome ſeconds later
20..47..26	The emerſion of Mercury's centre
20..49..16	Mercury's eaſtern edge quits the diſc
20..49..41	Mercury has quitted the diſc certainly

The nine firſt obſervations end with 30″, becauſe they were really made only to a minute, and 2′.. 30″ were added to give the true time, but the four laſt were taken with greater preciſion.

Plate VIII. Fig. 3. Repreſents the tranſit with the principal ſpots.

Places	Obſervers	Contact interior obſerved	Contact exterior obſerved	Departure of the centre obſerved
Louvain	Pigott	20h..45′..41″	20h.49′.16″	20h.47′28″,5
Greenwich	Maſkelyne		20..30..37	
Lampit-hill	Woolaſton		20..30..32	
Lampit-hill	Aubert		20..30..34	
Paris obſ.	Lambre		20..39..56	
Paris Hot. Cl.	Meſſier	20..36..28,25	20..39..51,75	20..38..13
Manheim	Koenig	21.. 0..17,25	21.. 4..13,63	21.. 2..15,44
London	Roy	20..26..52,2	20..29..52,2	20..28..22,2
Milan	Ceſaris	21.. 2..29	21.. 6..59	21.. 4..44
Padua	Toaldo	21..13.. 8	21..17..31	21..15..19,5
Griefswolde	Rohb.	21..19..39	21..23..33	21..21..36

From the different accounts given of the time elapſed between the contacts of the two edges of Mercury with the ſun's edge, there is evidently great difficulty in determining preciſely the time of contact. The obſervations are noted according to true time.

On The PLANET HERSCHEL.

This Paper was preſented to the Academy on the 20th of May, 1785, by FRANCIS DE ZACH, *Profeſſor of Mathematics, &c.*

THE diſcovery of a new planet viſible to a good eye without glaſſes, and ſeen perfectly well with an opera glaſs, forms a conſiderable epoch in the hiſtory of aſtronomy; and the year 1781 will be diſtinguiſhed for the addition of a ſeventh planet to our ſyſtem. This diſcovery was made by Frederick William Herſchel, who was born at Hanover in 1738, and, though deſtined to be a muſician, was led by the force of genius to cultivate mathematics and aſtronomy. For twenty years he practiſed muſic at Bath, during which time he applied himſelf with ardour to aſtronomy, and finding ſoon that his ſmall teleſcopes did not anſwer his deſigns, he took a journey to London, to procure one of the beſt of Dolland's. The expence was too great for his finances. He reſolved to conſtruct one, both caſting and poliſhing the ſpeculum himſelf. Having ſucceeded in his firſt attempt, he continued his exertions, and made teleſcopes from two to twenty feet in length, with powers 227, 460, 932, 1536, and 2010. In 1782 Maſkelyne compared one of theſe teleſcopes with one of the beſt of Short's, and gave the preference to the former, and the king of England becoming the patron of Herſchel, ſettled him in a houſe at Datchet, near Windſor, on a penſion of 200l. a year. In 1781, the Royal Society inſcribed him among its members, and adjudged to him the gold medal; which is deſtined every year to the moſt intereſting diſcovery in the Arts and Sciences.

About the end of the year 1780, he was employed in attempting to find the annual parallax of the fixed ſtars, and on the 13th of March 1781, whilſt he was examining between 10 and 11 in the evening, the little ſtars in the neighbourhood of H of Gemini, he perceived one that ſeemed to be larger than the others, and to have a diſtinct diſc: on comparing it with H of Gemini, and the little ſtar in the rhombus between Auriga and Gemini, he found it much greater than either, and ſuſpected it to be a comet. His teleſcope magnified 227 times, but on this ſuſpicion he obſerved it with a power 460, and then with one of 932, and found, that whilſt the other ſtars remained the ſame, the diameter of this increaſed with the power, and, when the power was too great for the light of the planet, it appeared confuſed and ill defined.

With an excellent micrometer of his own conſtruction, he obſerved the increaſe of its apparent diameter, which on the 17th of March was $2''..53'''$, and on the 18th of April $5''..2'''$. Then by meaſuring its diſtance from ſome teleſcopic ſtars, he found that this in two days had changed its place, and that its apparent horary motion was $2''\frac{1}{4}$. He obſerved that it moved in the order of the ſigns, that its orbit made a very ſmall angle with the ecliptic, that it had no viſible atmoſphere or tail, and that the circumference of the diſc was well defined.

Herſchel communicated this diſcovery to the Royal Society. Maſkelyne ſaw the planet on the 17th of March, at nine in the evening, but did not make any accurate obſervations, till the firſt of April. On the 29th of March, Hornſby determined at Oxford its geocentric longitude for that day at 8*h*..5′..16″, mean time to be 2s..24°..43′..35″, its geocentric latitude north, 11′..37″,1. Meſſier was the firſt, who on the 16th of April obſerved it at Paris. The aſtronomers at Brera in the Milaneſe, did not diſcover it till the 12th of May, and Slop de Cadenberg, aſtronomer at Piſa, ſaw it juſt before the end of the month.

Maſkelyne and Meſſier made the neareſt obſervations to the conjunction. The former noticed at Greenwich on the 28th of May, 9*h*..2′ in the evening its Rt. aſc. 87°..5′42″, and dec. N. 23°..37′..38″. The latter on the ſame day, 8*h*..49′..30″ in the evening noted at Paris its Rt. aſc. 87°..5′..3″, and dec. N. 23°..37′..57″.

On the 19th of June 5°..31′, its conjunction with the ſun was in longitude 2s..28°..38′..14″, and in N. lat. 11′..51″.

Every one waited with impatience for its re-appearance. Meſſier obſerved it firſt at Paris on the 17th of July, 1781, 15*h*..11′25″ its Rt. aſc. being 90°..19′..17″, and its N. dec. 23°..40′..11″. On the 19th of July 3*h*..11′, it was ſeen at Greenwich, its longitude being 3s..0°..24′..11″. The other aſtronomers of Europe, ſaw it at more remote intervals, according to the intelligence they received from various quarters.

The apparent diameter of the planet now became the ſubject of obſervation. Maſkelyne eſtimated it at 4″ or 5″, and thought that it was of the ſame whitiſh colour with Jupiter. Meſſier did not perceive that its diameter had increaſed. It appeared to Ceſaris conſtantly 5″. Oriani computed it at the end of October at 6″ or 7″, and was certain that its light was increaſing. Darquier remarks the latter circumſtance, but thought that its apparent diameter had not varied. Fixlmüllner of Cremſmünſter, compared it to a ſtar of the fifth magnitude, but not ſo brilliant. Mayer computed its apparent diameter at 9″ and 11″ in which he was evidently wrong.

The planet became ſtationary in the beginning of October. On the 9th of October it began its retrograde motion, on the 25th of September it came to its weſtern quadratum, and on the 21ſt of December, 18*h*. it was in oppoſition with the ſun. Its true heliocentric longitude was calculated for that day by ſeveral obſervers as in the following table.

Mean time at Greenwich.	Heliocentric Longitude	Obſervers.
h. ′ ″	s ° ′ ″	
17..57..14	3..0..52.. 6,3	Slop, at Piſa
18.. 4..3,1	3..0..52..21,7	Mayer, at Manheim
18.. 1..57	3..0..52..17,2	Pigott, at York
18.. 9..27,1	3..0..52.. 9,3	Mechain, at Paris

Several perſons employed themſelves in calculating the orbit, conſidering it firſt as parabolical. Lexel of Peterſburg being in England at the time of the diſcovery, made the perihelion diſtance 6,009, and longitude of the perihelion 6s..17°..9′¼, but he ſoon found that his parabola did not correſpond with the following obſervations. De la Place made the perihelion diſtance 9,4404, the place of the perihelion 5s..28°12′½ comet in the perihelion 27th of January 1790, at 6*h*..19′ in the evening, motion direct. The firſt obſervations after the conjunction ſet theſe elements aſide. De la Place then made four parabolas, which agreed with the firſt obſervations: in the two firſt, the diſtance of the comet from the earth was nearly equal to the mean diſtance of the earth from the ſun; a few days obſervations ſet theſe alſo aſide, but it required ſome months to reject the two others, in which the diſtance of the comet from the earth was made 18 or 19 times greater than before. At the ſame time Lexel being in England, found two parabolas, in one of which the error did not amount to four minutes in eight months, in the other it was about nine minutes in ſix months. Ceſaris, at Milan, made the perihelion diſtance 10,2756, the longitude of the perihelion 5*s*..22°..16′, place of the node 2*s*..25°..13′, inclination of the orbit 5°..16′, comet in the perihelion 13th May 1790, motion direct. Paccazi at Vienna made the perihelion diſtance 3,589694, longitude of perihelion 5*s*..15°..59′..39″, comet in the perihelion 13th January 1780, 22*h*..45′, place of the node 5*s*..2°..19′..13″, inclination of the orbit 14′..23″, motion retrograde. Bode ſoon found that the obſervations in December differed thirteen degrees from this calculation.

Lexel firſt rejected the parabola, and, ſuppoſing the orbit to be nearly circular, made its radius 189,28 the diſtance of the earth from the ſun being 10, and determined the periodic time 82*y*..4*m*. its annual heliocentric motion from the obſervations of Maſkelyne on the 17th March, and Darquier on the 31ſt July, 1°..38′..19″, was from his calculation 1°..37′..9″. He afterwards determined the radius more accurately 189,1724, longitude of the node 2*s*..12°..22′..33″, inclination of the orbit 45′..28″. Bochard de Saron determined the planet's diſtance to be twice as far from the earth as Saturn. Bode made the radius 189,28, and the periodic time 82*y*..4 *days*. Oriani made the radius 208,734, and its revolution 95*y*..133½*d*. I made in April 1782 the radius 189,917, per time 82,892 years. De la Lande made the radius 189,31 per time 82,37 years. Slop de Cadenberg—radius 189,894, per time 82,74979 years, longitude of node 2*s*..14°..24′..20″, inclination of the orbit 50′..41″. The greateſt errors in this hypotheſis from 22d Auguſt to the 14th March 1782, did not exceed 0′½ in longitude and 17″ in latitude. Hennert at Utrecht fixed the radius 188,351, longitude of the node 2*s*..14°..30′, inclination of the orbit 50′..55″, per time 81,744 years. Errors from this hypotheſis 1 in longitude and half a minute in latitude. Klügel of Helmſtadt made the radius 190,096, and per time 82,8818 years. Bode by Klügel's method made the radius 190,09, and per time 82 years 10 months from two obſervations of Maſkelyne on 17th March, and 28th May 1781. From obſervation of Maſkelyne on 28th May, and one of Darquier on the 3d of Auguſt he made the radius 188,44 per time 82 years: From obſervations of Darquier on 3d Auguſt and 28th September 1781, he made the radius 189,05, per time 82 years 2 months: From obſervations of Mayer on 4th November 1781, and 1ſt February 1782, he made the radius 189,92, per time 82 years 6 months, whence he fixed on a medium, the radius 189,38, per time 82 years 5 months.

At the end of July 1782 De la Lande informed Bernonilli at Berlin, that the geocentric longitude of the planet differed 1′..5″6 from his calculation, which increaſed ſoon after to 2′½. Hennert found that his calculations were too great by 38″ in longitude, and 15″ in latitude. This led the aſtronomers to conſider the orbit as elliptical.

In the beginning of 1782 the planet was ſtill retrograde; on the 7th March it became ſtationary in longitude 2*s*..28°..49′..30″, and N. latitude 15′..14″. On the 10th March its longitude was 2*s*..28°..49′..56″. On the 19th it was in quadrature in 2*s*..28°..24′. De la Lande obſerved it on the 29th of May 9*h*..18′ in the evening, in longitude 2*s*..1°..34′. On the 24th of June it was in conjunction with the ſun in longitude 3*s*..3°—5′..40″, latitude 15′..19″.

De la Lande was the firſt who ſaw it again on the 19th of July at 4*h.* in the morning, it came to its quadrature on the 30th of September, and was on the 26th of December in oppoſition. On that day its heliocentric longitude was taken as in the following table.

Mean time at Greenwich	Heliocentric Longitude	Obſervers
h ′ ″		
9..14..34	3..5..20..44,9	Pigott, at York
9..12..53	3..5..20..31,8	Robinſon, at Edinburgh
9..11..48	3..5..20..48,7	De la Lande, at Paris

Its mean diurnal heliocentric motion was now computed at about 43″.

In conjunction with the ſun its diurnal geocentric motion was 3′..36″, in oppoſition 2′..48″. Every year the planet was progreſſive 215 days, and retrograde 150 days.

Mechain gave the following elements for its elliptic orbit. Mean diſtance of the earth from the ſun being Unity.

Semi axis major	19,07904
Aphelion diſtance	19,89938
Perihelion diſtance	18,25870
Excentricity	,82034
	° ′ ″
Mean anomaly counted from the aphelion 1781, the 11th of May 8*h*..47′ mean time at Paris	79.. 9..55
Longitude from the aphelion that day	5*s*..22..13..17
Heliocentric longitude of planet that day	2..28..10..24,5
Longitude of the aſcending node	2..11..49..30
Inclination of the orbit	43..35
Planet in the aphelion the 7th of November 1799, mean time at Paris 7*h*.	
Periodic time	83*y*.. 4*m*..0

This elipſe agreed with the obſervations to nearly 8″ in longitude.

De la Place gave the following elements.

Semi axis major	19,0818
Excentricity in ſeconds	9816″
	° ′ ″
Greateſt equation of the centre	5..27..12
Longitude from the aphelion, 21ſt of December 1781	11*s*..23..22.. 0
True anomaly 18*h*..5′..40″, mean time at Paris	97..29..19
Longitude of the aſcending node in 1781	72..47.. 0
Inclination of the orbit	46..13

Theſe elements correſponded to the obſervations to about 5″.

Hennert gave the following elements.

Semi axis major	19,02766
Excentricity	,042664
	° ′ ″
Greateſt equation of the centre	4..53..16
True anomaly correſponding	2*s*..28.. 9..53
Longitude from the aphelion 15th of May, 1781,	11..20.. 5..40
Longitude of the aſcending node	2..11..10..45
Inclination of the orbit	42..13
Periodic time	83*y*..2*m*

Logarithm of the parts of a degree that the planet deſcribes by its mean diurnal motion = 8,0746433

Theſe elements differ about 2′ from the obſervations.

To learn whether this planet might have been ſeen by former aſtronomers and noted as a ſtar, reſearches were made among ancient catalogues of the ſtars. Bode ſuſpected that the 27th ſtar of the ſixth magnitude in Capricorn, according to Tycho

Brahe's catalogue of 777 ſtars, which Bayer calls *d*, was the planet, as Hevelius could not find it in 1650. Suppoſing that Tycho had obſerved this ſtar in 1587, its longitude was for that year 10*s*..20°..4′, now in the beginning of 1781 the planet's longitude was 2*s*..26°..30′ ∴ the difference = 4*s*..6°..26′. On calculating the planet's place for 1587, that is 194 years backwards, he found that after two revolutions and 4*s*..6°..26′ it muſt have been near *μ* in Capricorn, juſt above which was Tycho's ſtar. The latitudes do not agree ſo well. Bode ſuppoſes that there is an error in the latitude of *μ* from whence Tycho meaſured the diſtance of the 27th ſtar or *d*; and that inſtead of 41′½, he wrote 14′½, for Hevelius makes it 34′½, Flamſtead 39′..10″, Bradley 40′..3″, Zanotti 39′..39″.

In 1756 Mayer obſerved a little ſtar near *φ* in Aquarius, the 964th ſtar of his zodiacal catalogue, which was not to be ſeen in Auguſt 1781. The right aſcenſion of this ſtar in 1756 was 348°..0′..20″,2, declination N. 6°..2′..3″, from whence Bode makes the longitude 11*s*..16°..52′ latitude N. 48′. The planet, according to Bode's calculation, was at that time in 11*s*..17° with a northern latitude, whence he concludes that Bayer had ſeen it.

To aſcertain this fact Mayer's manuſcripts at Goettingen were examined, and it appeared that he had ſeen this ſtar only once on the 25th September 1756, on which day its longitude was 11*s*..16°..37′..54″. Suppoſing the planet's diſtance from the ſun 18,938, longitude of the node 2*s*..12°, inclination of the orbit 45′, Bode determined the heliocentric longitude of the planet 11*s*..17°..29′..21″, and latitude N. 44′..45″. Taking its obſerved mean motion of 1°..12′..25″ in 100 days, he found with the ſame elements, that its heliocentric place on the 25th September was 11*s*..9°..35′..41″ longitude and 44′..30″ latitude, the difference in longitude and latitude in the two calculations might proceed from the change made in 25 years from the excentricity of the orbit. Hence it is reaſonable to conclude that Mayer's ſtar was the planet.

I calculate that Mayer's obſervation was made 25th September 10*h*..51′..33″ mean time at Goettingen. De la Place makes it 10*h*..21′..18″ mean time at Paris.

From this obſervation of Mayer compared with others, and taking a mean of the reſults, De la Place determined the poſition of the node and the inclination of the orbit. The following elements were given by him.

Semi axis major	19,0818
Excentricity in ſeconds	9815″,5
Greateſt equation of the centre	5*s*..27°..11′
Mean anomaly from the aphelion, 1ſt. of January 1782, noon, mean time Paris	102..59..31″
Longitude from aphelion that day	353..22..59
Longitude of aſcending node	73.. 1.. 0
Inclination of the orbit	46..12
Logarithm of ſeconds deſcribed daily by the mean motion	1,6290783

Periodic time 30445,75 days, or a little more than 83⅓ years.

To theſe elements I have added

Semi axis minor	19,0602
Aphelion diſtance	19,9898
Perihelion diſtance	18,1738
Excentricity	,9080457
Mean heliocentric diurnal motion in orbit	42″,56753
on the ecliptic	42.70518
Annual heliocentric motion in orbit	4°..18′..57″,14845

Geocentric longitude of the planet the 25th of September 1756, at 10*h*..51′..30″ was 11*s*..16°..37′..59″

Longitude of Mayer's ſtar was 11*s*..16°..37′..54″, difference only 5″

De la Place found the difference of longitude + 11″, and in latitude 10″

Hornſby drew up ſeveral obſervations, which being compared with the elements of De la Place, did not differ very materially. The greateſt difference in longitude was 21″,7, the greateſt difference in latitude 13″,2.

In the beginning of the year 1784, Bode finding that the 34th ſtar of Taurus, in Flamſtead's catalogue, was no longer viſible, and that on the 23d of December 1690, the planet's place differed from that of the ſtar only by 1°..44′ longitude, and 1′..38″ latitude, or ſuppoſing the periodic time of the planet 83*y*..224*d*. by 25′ longitude, and 36″ latitude, conjectured that Flamſtead had ſeen the planet. By my calculation the difference in longitude was 2°..47′..39″, and in latitude, 1′..28″, by purſuing the ſame mode of calculating, that of De la Place. Bode found afterwards exactly the ſame differences. Fixlmüllmer taking this obſervation, and another of Flamſtead's in 1690, with that of Mayer in 1756, and two oppoſitions in 1781, and 1783, determined the elements, which agreed with the obſervations of Flamſtead, Mayer and all the moderns, within a few ſeconds. I find that the true time of Flamſtead's obſervation was 1690 $\frac{13}{23}$ $\frac{\text{OS}}{\text{NS}}$ December 9*h*..31′..47″ at Greenwich. Its apparent right aſcenſion 55°..49′..28″,5, declination N. 19°..35′..24″, the obliquity of the ecliptic being 23°..29, the longitude was 1*s*..28°..2′..50″, latitude N. 10′..34″.

Klinkenburg renewing the enquiries after the 27th ſtar of Capricorn, in Tycho's catalogue, found in the library of the Prince of Orange, at the Hague, four obſervations on this ſtar, in a catalogue of obſervations written by Tycho himſelf.

1. 1589. 30. October, in the evening. 17°..12′½ N declination.
2. 1589. 20. November, diſtance meaſured between γ of Piſces and the twenty ſeventh ♑, 26°..41′¾.
3. 1590. 22. September — 10°..55′ } N. declination.
4. 1590. 10. November — 15.. 25 }

Klinkenburg determines the longitude of this ſtar, for the 20th of November, 1589. 8*h* in the evening, 10*s*..19°..58′..50″,56. De la Lande, in the Memoirs of the Academy at Paris for 1779, objects that the planet was too ſmall to be obſerved by Tycho, who was not acquainted with the uſe of teleſcopes, but Bode replies, that ſince he could ſee the 27th ſtar, which is not greater than the planet, and mark it of the ſixth magnitude, he might certainly have ſeen the planet.

Our obſervations of enquiries having extended thus far, it remains only to conſider the proper name for this planet. Herſchel, in honour of the King of England, called it the Georgium Sidus, the French, in honour of the diſcoverer, called it Herchel; other names have been propoſed, ſuch as Neptune, Cybele, Aſtrea, Minerva, &c. Bode gave it the name of Ouranus, who was the father of Saturn, as Saturn was of Jupiter. Different marks have been propoſed for it. In France, $\frac{1+1}{\circ}$; in England H⌣ ſome propoſed ſtags horns, alluding to Herſchel's name, which in German ſignifies a young ſtag. Koehler propoſed the ſign of the new metal platina del Pinto, which ſign, and the name Ouranus have been adopted by the Academy Royal of Pruſſia, and introduced into its aſtronomical ephemerides.

Note. The honour of this diſcovery is due to Herſchel, the heathen mythology is now out of uſe, and notwithſtanding the ſanction of the Pruſſian Academy, and the writer of this paper, who intitles it Ouranus, the Engliſh with great reaſon ſeem inclined to adopt the appellation Herſchel, and enliſt an aſtronomer who does honour to this country among the gods of the ancients.

ASIATICK RESEARCHES, Vol. II. 4to. *Calcutta*, 1790.

IN an advertiſement prefixed to this volume, the ſociety expreſſes a wiſh, that the learned ſocieties of Europe would tranſmit to their ſecretary in Bengal, a collection of ſhort and preciſe queſtions on every tract of Aſiatick hiſtory, natural and civil. On the philoſophy, mathematicks, antiquities, and polite literature of Aſia; and on Eaſtern arts, both liberal and mechanical, to which they hope accurate anſwers may in time be procured.

I. *Fourth Anniverſary Diſcourſe, delivered* 15*th February*, 1787. *By the* PRESIDENT.

HAVING propoſed to diſcourſe on the *five* principal nations of Aſia; and having remarked on the old inhabitants of India, the preſident proceeds to treat of other nations, who, from a ſimilarity of language, &c. may be ſuppoſed to have had an early connection with the *Hindus*. On this diſcourſe he proceeds to give a ſhort account of a people who ſeem in every reſpect to be a diſtinct race from them.

He now means to ſpeak of Arabia, and as the old Arabian geographers apply it, to that extenſive peninſula which the Red Sea divides from Africa, and the Great Aſſyrian river from Iran. He thinks Arabia was not connected with Hindoſtan until navigation and commerce had been conſiderably improved; but as they were both commercial nations in a very early age, they probably had ſome connections together.

The Arabs have never entirely been ſubdued, but have reformed their primitive manners, language, features, and character, as remarkably as the Hindus themſelves, to whom they form a ſtriking contraſt.

The ancient hiſtory of this race has been little known in detail before *Dhû Yezen*. The preſident, therefore, has recourſe as a media for inveſtigating the hiſtory of the Arabs to their *language, letters, religion, ancient monuments, and remains of arts.*

1. With reſpect to the Arabian language, the Europeans are indebted to their knowledge of it to Holland; and by help of the grammar and dictionary of Erpenius, may eaſily become maſters of the learned *Arabick*. The *Arabick* yields to no language in the number of its words and preciſion of its phraſes, but bears not the leaſt reſemblance to the *Sanſcrit*, it ſo much abhors a compoſition of words, that if any compound word is found therein, it may be deemed an exotic. It is the genius of the *Sanſcrit* language, that the root of verbs are univerſally *biliteral*, in the Arabick they are as univerſally triliteral: ſo that the compoſition of the twenty-eight Arabian letters will give near 22,000 elements of the language. So totally diſtinct are thoſe two languages, that the preſident recollects only one word in common between them.

He concludes this head with remarking, that the nature of the *Ethiopick* dialect ſeems to prove an early eſtabliſhment of the Arabs in a part of Ethiopia, from which they were afterwards expelled. Of the characters in which the old compoſitions of Arabia were written, little is known, except that the Koran originally appeared in that of *Cúfah*, from which the modern *Arabian* letters were derived, and which unqueſtionably had a common origin with the *Hebrew* or *Chaldaick*. As to the *Himyarick* letters, or thoſe mentioned by the name of *Almuſnad*, we are ſtill in total darkneſs.

2. It is generally aſſerted that the old religion of the Arabs was entirely *Sabian*; but of the nature of this nothing can be ſaid with confidence. It is however certain,

that the people of *Yemen* ſoon fell into the error of adoring the ſun and the firmament, though the religion of the poets at leaſt ſeems to have been pure theiſm. We are told that a ſtrong reſemblance may be found between the religions of the pagan Arabs and the Hindus; and the repreſentation of the *powers* of God as *female* deities, the adoration of *ſtones*, and the name of the idol WUDD, may lead to the ſuſpicion that ſome Hindu ſuperſtitions had found their way into Arabia. A conjecture alſo may be formed, that SESAC and SA'CYA were the ſame perſon, who, about a thouſand years before Chriſt travelled eaſtward from Ethiopia, as a warrior or lawgiver, and whoſe rites are now extended as far as the country of *Niſon*. If his religion, however, was really introduced into Arabia, it could not have been general there; and we may ſafely pronounce, that before the Mahommedan revolution, the noble and learned Arabs were theiſts, but that a ſtupid idolatry prevailed among the lower orders of people. No traces are to be met with among them in thoſe periods of any philoſophy but Ethics, in which their diſtinguiſhing virtues were a contempt of riches and of death. But their morals were miſerably depraved for a century at leaſt before Muhammed.

3. Few monuments of antiquity are preſerved in Arabia, and of thoſe few the accounts are very uncertain. Inſcriptions on rocks and mountains are ſtill ſeen in various parts; and the firſt *Albert Schultens* has preſerved two little poems in an elegiac ſtrain, ſaid to have been found about the middle of the ſeventh century on ſome fragments of ruined edifices in *Hadramût* near *Adan*, and thought to be of a very remote age. The ſuppoſed houſes of the people called *Thamûd* are ſtill to be ſeen in excavations of rocks. The *Câbah* or quadrangular edifice at *Meccah* is ſo old, that its original uſe, and the name of its builder are loſt in a cloud of idle traditions. Moſt probably it was deſigned for religious purpoſes.

It is difficult to fix the chronology of the *Iſmaëlites* beyond the time of ADNAN, from whom Muhammed was deſcended in the 21ſt degree; and although we have genealogies of ALKAMAH and other *Himyarick* bards as high as the 30th degree, yet their accuracy can hardly be depended upon for a chronological ſyſtem. It is the univerſal tradition of *Yemen*, that YOKTAN, the ſon of EBER, firſt ſettled his family in that country; which ſettlement, by the European computation, muſt have been above 3600 years ago. According to this calculation, NUUMAN, king of *Yemen*, in the ninth generation from EBER, muſt have been contemporary with JOSEPH; and if a verſe compoſed by that prince, and quoted by ABULFEDA, is genuine, it proves the high antiquity of the Arabian language and metre. On the whole, it ſeems certain that the *Arabs*, both of *Hejàz* and *Yemen*, ſprung from a ſtock entirely different from that of the *Hindus*, and that their firſt eſtabliſhments in their reſpective preſent countries were nearly coeval.

4. The manners of the *Hejázì Arabs*, which have remained the ſame from the age of Solomon to the preſent day, were by no means favourable to the culture of *arts*; and as to *ſciences*, we have no reaſon to believe they ever had any; for the mere giving names to ſtars, and making obſervations on the weather can ſcarcely be entitled to the name of aſtronomy. The only arts in which they could pretend to excellence were *poetry* and *rhetoric*. Though we have none of their proſe compoſitions before the Koran, it is certain that they were highly eloquent; but from the little ſkill they poſſeſſed in the art of writing, even their old poems, which are now acceſſible to us, were probably originally unwritten. The preſident here remarks, that he is inclined

to think Dr. Johnſon's reaſoning on the extreme imperfection of unwritten languages too general, and that ſuch a language may be highly poliſhed by a people who, like the ancient Arabs, made the improvement and tranſmiſſion of it a national concern.

The people of *Yemen* had probably more mechanical arts, and perhaps more ſcience, as their ports were conſiderable emporia; yet we have no certain proofs of their proficiency in navigation or manufactures. The Arabs of the Deſart had muſical inſtruments, and gave names to the notes; but the firſt were probably very ſimple; and the muſic may be ſuſpected to have been little more than a tuneful recitation of their verſes.

II. *The Fifth Anniverſary Diſcourſe, delivered to the Society, Feb.* 21, 1788.

THE preſident underſtands the term *Tartary* in the ſame extenſive ſenſe that he gave to the appellations of India and Arabia; including in it the whole of Aſia from the borders of Perſia, India, China, and Corea, to the Icy ſea, and alſo Crim Tartary and part of Ruſſia. Of this vaſt region, nearly one fourth is in the ſame climate with Greece, Italy, and Provence; another fourth in that of England, Germany, and the north of France; the reſt, in every degree of northern latitude to the extremity of the land. *Scythia* ſeems to have been the general name which the ancient Europeans gave to as much as they knew of this country; but neither that name, nor the modern *Tartary*, are thoſe by which the inhabitants have ever diſtinguiſhed themſelves. *Tátar* is by ſome conſidered as the name of a particular tribe; but debates concerning names are of little conſequence, when our ideas are diſtinct without them.

After touching upon the fanciful ſyſtem of the ingenious Mr. Bailly, that all arts and ſciences had their origin in the moſt northern parts of *Scythia*, about the banks of the *Jeniſea*, and that the earthly paradiſe was ſeated in or near *Nova Zembla*; the preſident declares his intention of briefly diſcuſſing the queſtion concerning the ſtate of knowledge in ancient Tartary, under the heads eſtabliſhed in the former diſſertations. He obſerves, that notwithſtanding the wide extenſion and different modes of life of the numberleſs communities of Tartars, a family reſemblance may be perceived in all, eſpecially in the eyes and countenance, forming what we generally call a *Tartar* face. From thoſe we now ſee, and from the original portraits of TAI'MU'R and his deſcendants, we may conclude that the Tartars in general differ wholly in complexion and countenance from the Hindus and Arabs.

Hence the account given by the modern Tartars, of their common deſcent from one anceſtor, is in ſome degree confirmed. This lineage cannot be proved by authentic pedigrees or hiſtorical monuments; for all their writings extant, even thoſe in the *Mogul* dialect, are long ſubſequent to the time of Muhammed; nor is it poſſible to diſtinguiſh their traditions from thoſe of the Arabs. At the beginning of the 14th century, *Khwájah*, ſurnamed FAD'LU'LLAH, compiled his account of the Tartars and Moguls from the papers of one *Púlád*, who had been ſent into Tatariſtan for the ſole purpoſe of collecting hiſtorical information. From this work, and from other materials, ABU'LGHA'ZI' king of *Khwa'reſm*, compoſed in the Mogul language his genealogical hiſtory, which has appeared in ſeveral European tongues. It is to the period preceding CHENGIZ that the preſident means to confine his remarks, only premiſing from ancient Chineſe hiſtory, that the firſt king of the *Hyhumnús*, or *Huns*, began his reign, according to Father *Viſdelou*, about 3560 years ago, not long after the time fixed for the firſt eſtabliſhment of the Hindus and Arabs.

1. With reſpect to the language and literature of the Tartars, it is all a deplorable void. The Tartars had no literature, the Turks had no letters, and the Huns had not ever heard of them. The mighty Chengiz could find none of his own *Mongals* able to write his diſpatches; and Tai'mu'r, though paſſionately fond of having hiſtories read to him, could himſelf neither write nor read. It is true, that Ibnu Arabsha'h mentions a ſet of characters, called *Dilbergín* which were uſed in *Khátá*. But this was in ſouthern Tartary, on the confines of India; and from his deſcription of them we cannot but ſuſpect them to have been thoſe of Tibet, which are manifeſtly Indian. He ſays further, that in *Jaghatáë*, the people of *Oïghúr* have a ſyſtem of fourteen letters only, denominated from themſelves *Oïghúrì*; and thoſe are the characters which the *Mongals* are ſuppoſed by ſome to have borrowed. *Abúlgházì* tells us only that Chengiz employed the natives of *Eïghúr* as excellent penmen; but the Chineſe aſſert that he was forced to employ them, becauſe he had no writers at all among his natural-born ſubjects; and we are aſſured by many that *Kublaikhán* ordered letters to be invented for his nation by a Tibetian, whom he rewarded with the dignity of chief *Lama*. If the Tartars in general had no written memorials, their language muſt have been in perpetual fluctuation, ſo that it is no wonder, that, as Hyde was informed, more than fifty dialects ſhould be ſpoken between Moſcow and China by the many hundred tribes or their branches. The *Turkiſh* of Conſtantinople is ſo copious, that whoever ſhall know it perfectly, will, as we are aſſured, eaſily underſtand the dialects of *Tatariſtan*; and we may collect from *Abúlgházì* that he would find little difficulty in the *Calmac* and the *Mogul*. From a careful inveſtigation, the preſident is convinced, that as the Indian and Arabian tongues, ſo thoſe of Tartary might ſeverally be traced to one ancient ſtem, eſſentially different from the two others. The dialect of the Moguls, in which ſome hiſtories of *Taimúr* and his deſcendants were originally compoſed, is called in India, *Turcì*, not that it is entirely the ſame with the Turkiſh, but a very reſembling idiom.

2. We are told by *Abúlgházì*, that the primitive religion, or adoration of one Creator, prevailed in Tartary during the firſt generation from Ya'fet, but was extinct before the birth of Oghu'z, who reſtored it in his dominions: that ſome ages after him, the Mongals and Turcs relapſed into groſs idolatry; but that Chengiz was a pure theiſt, who admitted all the arguments of the Mahommedan doctors concerning the being and attributes of God, while he conteſted the evidence of the prophet's legation. From old Grecian records we learn that the *Maſſagetæ* worſhipped the ſun; and the narrative of an embaſſy from the emperor *Juſtin* to the *Khakán*, who then reſided in a fine vale near the ſource of the Irtiſh, mentions the ceremony of purifying the Roman ambaſſadors by conducting them between two fires. The Tartars of that age are repreſented as adorers of the four elements, and believers in an inviſible ſpirit, to whom they ſacrificed bulls and rams. Modern travellers relate, that in the feſtivals of ſome Tartarian tribes, they pour a few drops of a conſecrated liquor on the ſtatues of their gods; after which an attendant ſprinkles a little of what remains three times towards the ſouth in honour of fire, towards the weſt and eaſt in honour of water and air, and towards the north in honour of the earth, which contained the reliques of their dead anceſtors. But, as the preſident reaſons, all this may be true without proving a national affinity between the Tartars and Hindus: for the Arabs, whom we certainly know to be a diſtinct race, had ſimilar objects and rites of worſhip; as well as a ſimilarity of manners in their Nomades or wandering ſhepherds, to thoſe who wandered over the plains of Tartary.

Many *Lamas*, or prieſts of Buddha have been found ſettled in Siberia, where it can hardly be doubted that they travelled from Tibet; from which country it is probable that the religion of the *Buddhas* was imported into Southern Chineſe Tartary; and many reaſons may lead us to ſuſpect, that it was carried from the weſt and ſouth to thoſe eaſtern and northern parts where it now prevails. On the whole, we meet with few or no traces in Scythia of Indian rites and ſuperſtitions, or of the poetical mythology of the *Sanſcrit* poems. And though the Tartars might have had more reaſon for the worſhip of the ſun than any ſouthern people, we need not admit them to have been the ſole inventors of that worſhip; or of the veneration for the four elements, which forms a conſiderable part of the ritual of Zera'tusht, the Perſian.

Of any philoſophy, except natural ethics, no veſtiges are to be found in Tartary and Scythia, and *Anacharſis* is the only perſon whom the ancients have recorded as a philoſopher, who was the ſon of a Grecian woman, and travelled into Greece. We are aſſured that the Tartars under *Chengiz* were lovers of truth, and the ſame virtue has been aſcribed to the Huns. Of the laws of Zamolxis we know nothing. A ſyſtem of laws called *Yaſac* has been celebrated in Tartary ſince the time of *Chengiz*, who is ſaid to have republiſhed them in his empire.

3. The only great monuments of Tartarian antiquity are a line of ramparts on the weſt and eaſt of the Caſpian, aſcribed by the Muſelmans to *Gog* and *Magog*, that is to the Scythians, but manifeſtly raiſed by a very different nation, in order to ſtop their inroads through the paſſes of Caucaſus. It is related that pyramids and tombs have been found in *Tatariſtan* or weſtern Scythia, and ſome remnants of edifices in the lake *Saiſan*; the Ruſſians have lately diſcovered the veſtiges of a deſerted city near the Caſpian, and the mountain of eagles; and golden ornaments and utenſils, figures of quadrupeds in metal, weapons, and copper implements for mining, have been dug up in the country of the *Iſhúdès*; but though theſe facts prove the high antiquity of the Tartars, and their eſtabliſhment in that country near 4000 years ago, they afford no proof of the affinity of their religion and ſcience with thoſe of India. Towards the end of the tenth century the emperor of China diſpatched an ambaſſador to a king of *Eighùr*, named *Erſlán*. On his return he reported the *Eighurſìs* to be a grave people, with fair complexions, diligent workmen, and ingenious artificers, not only in gold, ſilver and iron, but in jaſper and fine ſtones; and the Romans had before deſcribed their reception in a rich palace adorned with Chineſe manufactures. But if it were admitted that theſe people were, in ſome very early age, a literary and poliſhed nation, it would prove nothing in favour of the ſavage tribes to the north of Pekin, who ſeem in all ages before *Muhammed* to have been ferocious and illiterate.

4. The manners and character of the Tartars give us little reaſon to conclude that they were early proficients in arts and ſciences. Even in poetry we find no genuine ſpecimens aſcribed to them but ſome horrible war-ſongs, expreſſed in Perſian by *Ali* of *Yezd*. After the conqueſt of Perſia by the Mongals, indeed, their princes encouraged learning, and even made aſtronomical obſervations at *Samarkand*. But thus the Turks became poliſhed by mixing with the Perſians and Arabs; and the *Mantcheu* monarchs of China were patrons of learning.

The preſident next adverts to an opinion which he maintained before he left Europe, that the *Tuzuc* tranſlated by Major *Davy*, was never written by Tai'mu'r himſelf, for the plain reaſon that no Tartarian king of that age could write at all. In addition to the evidence which he then produced, he now mentions the teſtimony of the *Nawàb* Mozuffer Jung, who of his own accord aſſured him, that no man of ſenſe in Hinduſtan believed the work to have been compoſed by Taimu'r, but that it was written, after many confidential diſcourſes with him, by his favourite Hindu Sha'h.

If learning was ever anciently cultivated in the regions to the north of India, it was probably in thoſe countries of *Chineſe Tartary* which lie between the thirty-fifth and forty-fifth degree of north latitude; but the preſident means in a future diſſertation to produce reaſons for ſuppoſing that theſe countries were peopled by a race allied to the Hindus, or at leaſt enlightened by their vicinity to India and China. That ſome tribes of wandering Tartars were acquainted with the medicinal virtues of herbs and minerals, and pretended to ſkill in magic, may readily be admitted; but the general character of the nation ſeems to have been this: they were profeſſed hunters or fiſhers, dwelling on that account in foreſts or near great rivers, under huts or rude tents, or in waggons drawn by their cattle from ſtation to ſtation; they were dextrous archers, excellent horſemen, bold combatants, appearing often to flee in diſorder for the ſake of renewing their attack with advantage; drinking the milk of mares, and eating the fleſh of colts, and fond of intoxicating liquors.

The preſident concludes with ſuppoſing it proved beyond controverſy, that the far greater part of Aſia has been peopled and immemorially poſſeſſed by three conſiderable nations, whom, for want of better names, we may call *Hindus*, *Arabs*, and *Tartars*; each divided and ſubdivided into an infinite number of branches, and all ſo different in form and features, language, manners and religion, that if they ſprang originally from a common root, they muſt have been ſeparated for ages.

III. *The Sixth Diſcourſe, on the Perſians, delivered to the Society, Feb. 19th, 1789.*

By the name of *Perſia*, the Europeans underſtand the empire of *Iràn*, as it is correctly denominated by the preſent natives of it, and by all the learned Muſelmans who reſide in the Britiſh territories of India. Of this the preſident lays down its largeſt boundaries as follows. From the ſource of the Euphrates he deſcends to its mouth, including in the line ſome conſiderable diſtricts and towns on both ſides of the river; then paſſing the *Perſian Gulph*, he coaſts the ſouthern ſide of *Perſia*, till he arrives at the delta of the *Indus*; aſcending this river to the mountains of *Caſhgar*, he there diſcovers its fountains and thoſe of the *Jaihùn*, down which he is led to the *Caſpian*; from this, by the banks of the *Cur* or *Cyrus*, and along the *Caucaſean* ridges, he reaches the ſhore of the *Euxine*, which, together with the ſeveral *Grecian* ſeas, he coaſts till oppoſite the point whence he departed, the head of the *Euphrates*, at no great diſtance from the *Mediterranean*.

The ancient hiſtory of this empire is yet imperfectly known, the principal reaſons of which are the ſuperficial knowledge of the Greeks and Jews, and the loſs of the Perſian archives. The firſt Perſian emperor whoſe life the Greeks knew with tolerable accuracy was the great Cyrus, whom the preſident has no doubt in calling Caikhosrau, or the Khosrau of the poet *Firdausì*; for the Greeks conſtantly ſacrificed accuracy in foreign names to the melody of ſound as perceived in their own language. In the diſtractions that followed the overthrow of *Dara*, and the great revolution on the defeat of *Yezdegird*, the civil hiſtories of the Perſians were loſt; ſo that nothing remains of genuine Perſian hiſtory before the dynaſty of SA'SA'N, except a few ruſtic traditions and fables, which furniſhed materials for the *Sháhnámah*, and which are ſtill ſuppoſed to exiſt in the *Pahlavi* language. The annals of the *Píshdádí* or *Aſſyrian* race muſt be conſidered as dark and fabulous; and thoſe of the *Cayání* family, or *Medes* and *Perſians*, as heroic and poetical; though the lunar eclipſes ſaid to be mentioned by Ptolemy fix the time of *Guſtaſp*, the prince by whom *Zerátuſht* was protected. Of the Parthian kings deſcended from *Arſhac* or *Arſaces* we know little more than the names.

It had been ſettled by chronologers that the firſt monarchy eſtabliſhed in Perſia was the *Aſſyrian*, the commencement of which Newton fixed at about 200 years after *Solomon*. Of this opinion the preſident confeſſes himſelf to have been, till a fortunate diſcovery, for which he was indebted to *Alír Muhammed Huſain*, one of the moſt intelligent Muſelmans in India, diſſipated the cloud, and caſt a light on the primæval hiſtory of *Iran* and of the human race, which could ſcarcely have dawned from any other quarter.

"The rare and intereſting tract on twelve different religions, entitled *The Dabiſtàn*, and compoſed by a *Mohammedan* traveller, a native of *Caſhmír*, named MOHSAN, but diſtinguiſhed by the aſſumed ſurname of FA'NI', or *Periſhable*, begins with a wonderfully curious chapter on the religion of HU'SHANG, which was long anterior to that of ZERATUSHT, but had continued to be ſecretly profeſſed by many learned *Perſians* even to the author's time; and ſeveral of the moſt eminent of them, diſſenting in many points from the *Gabrs*, and perſecuted by the ruling powers of their country, had retired to *India*, where they compiled a number of books, now extremely ſcarce, which MOHSAN had peruſed, and with the writers of which, or with many of them, he had contracted an intimate friendſhip. From them he learned, that a powerful monarchy had been eſtabliſhed for ages in *Ìràn*, before the acceſſion of CAYU'MERS; that it was called the *Mahábádian* dynaſty, for a reaſon which will ſoon be mentioned; and that many princes, of whom ſeven or eight only are named in *The Dabiſtàn*, and among them MAHBUL, or MAHA' BELI, had raiſed their empire to the zenith of human glory. If we can rely on this evidence, which to me appears unexceptionable, the *Ìrànian* Monarchy muſt have been the oldeſt in the world; but it will remain dubious, to which of the three ſtocks, *Hindu*, *Arabian*, or *Tartar*, the firſt Kings of *Ìràn* belonged; or whether they ſprang from a fourth race diſtinct from any of the others: and theſe are queſtions which we ſhall be able, I imagine, to anſwer preciſely, when we have carefully enquired into the languages and letters, religion and philoſophy, and incidentally into the arts and ſciences, of the ancient *Perſians*.

"I. In the new and important remarks which I am going to offer on the ancient languages and characters of *Ìràn*, I am ſenſible, that you muſt give me credit for many aſſertions, which on this occaſion it is impoſſible to prove; for I ſhould ill deſerve your indulgent attention, if I were to abuſe it by repeating a dry liſt of detached words, and preſenting you with a vocabulary inſtead of a diſſertation; but, ſince I have no ſyſtem to maintain, and have not ſuffered imagination to delude my judgement; ſince I have habituated myſelf to form opinions of men and things from evidence, which is the only ſolid baſis of civil, as experiment is of natural, knowledge; and ſince I have maturely conſidered the queſtions which I mean to diſcuſs; you will not, I am perſuaded, ſuſpect my teſtimony, or think that I go too far, when I aſſure you, that I will aſſert nothing poſitively, which I am not able ſatisfactorily to demonſtrate. When Muhammed was born, and Anu'shi'rava'n, whom he calls the *Juſt King*, ſat on the throne of *Perſia*, two languages appear to have been generally prevalent in the great Empire of *Irán*; that of the Court, thence named *Derì*, which was only a refined and elegant dialect of the *Pársì*, ſo called from the province of which *Shìràz* is now the capital; and that of the learned, in which moſt books were compoſed, and which had the name of *Pahlavì*, either from the *Heroes* who ſpoke it in former times, or from *Pahlu*, a tract of land, which included, we are told, ſome conſiderable cities of *Iràk*. The ruder dialects of both were, and I believe ſtill are, ſpoken by the ruſtics in ſeveral provinces; and in many of them, as *Herát*, *Zábul*, *Sìſtàn*, and others, diſtinct idioms were vernacular, as it happens in every kingdom of great extent. Beſides the *Pársì* and *Pahlavì*, a very ancient and abſtruſe tongue was known to the Prieſts and Philoſophers, called the *language of the Zend*, becauſe a book on religious and moral duties, which they held ſacred, and which bore that name, had been written in it; while the *Pázend*, or comment on that work, was compoſed in *Phalavì*, as a more popular idiom; but a learned follower of Zera'tusht, named Bahman, who lately died at *Calcutta*, where he had lived with me as a *Perſian* reader about three years, aſſured me, that the *letters* of his Prophet's book were properly called *Zend*, and the *language Aveſtà*, as the words of the *Véda's* are *Sanſcrit*, and the characters, *Nágarì*; or as the old *Saga's* and poems of *Iſeland* were expreſſed in *Runick* letters. Let us however, in compliance with cuſtom, give the name of *Zend* to the ſacred language of *Perſia*, until we can find, as we ſhall very ſoon, a fitter appellation for it. The *Zend* and the old *Pahlavì* are almoſt extinct in *Iràn*; for among ſix or ſeven thouſand *Gabrs* who reſide chiefly at *Yezd*, and in *Cirmàn*, there are very few who can read *Pahlavì*, and ſcarce any who even boaſt of knowing the *Zend*; while the *Pársì*, which remains almoſt pure in the *Sháhnámah*, has now become, by the intermixture of numberleſs *Arabick* words, and many imperceptible changes, a new language, exquiſitely poliſhed by a ſeries of fine writers in proſe and verſe, and analogous to the different idioms gradually formed in Europe after the ſubverſion of the *Roman* Empire; but with modern *Perſians* we have no concern in our preſent enquiry, which I confine to the ages that preceded *The Mohammedan* conqueſt.

" Having twice read the works of Firdausi' with great attention, ſince I applied myſelf to the ſtudy of old *Indian* literature, I can aſſure you, with confidence, that hundreds of *Pársì* nouns are pure *Sanſcrit*, with no other change than ſuch as may be obſerved in the numerous *Cháſhá's*, or vernacular dialects, of *India*; that very many imperatives are the roots of *Sanſcrit* verbs; and that even the moods and tenſes of the *Perſian* verb ſubſtantive, which is the model of all the reſt, are deducible from the *Sanſcrit* by an eaſy and clear analogy. We may hence conclude, that the *Pársì* was derived, like the various *Indian* dialects, from the language of the *Bráhmans*; and I muſt add, that in the pure *Perſian* I find no trace of any *Arabian* tongue, except what proceeded from the known intercourſe between the *Perſians* and *Arabs*, eſpecially in the time of Bahra'm, who was educated in *Arabia*, and whoſe *Arabick* verſes are ſtill extant, together with his heroick line in *Deri*, which many ſuppoſe to be the firſt attempt at *Perſian* verſification in *Arabian* metre. But, without having recourſe to other arguments, *the compoſition of words*, in which the genius of the *Perſian* delights, and which that of the *Arabick* abhors, is a deciſive proof, that the *Pársì* ſprang from an *Indian*, and not from an *Arabian* ſtock. Conſidering languages as mere inſtruments of knowledge, and having ſtrong reaſon to doubt the exiſtence of genuine books in *The Zend* or *Pahlavì* (eſpecially ſince the well-informed author of *The Dabiſtàn* affirms the work of ZERA'TUSHT to have been loſt, and its place ſupplied by a recent compilation), I had no inducement, though I had an opportunity, to learn what remains of thoſe ancient languages; but I often converſed on them with my friend BAHMAN, and both of us were convinced, after full conſideration, that the *Zend* bore a ſtrong reſemblance to *Sanſcrit*, and the *Pahlavì* to *Arabick*. He had at my requeſt tranſlated into *Pahlavì* the fine inſcription, exhibited in the *Guliſtàn*, on the diadem of CYRUS; and I had the patience to read the liſt of words from the *Pâzend*, in the Appendix to the *Farhangi Jehángírí*: This examination gave me perfect conviction, that the *Pahlavì* was a dialect of the *Chaldaick*; and of this curious fact I will exhibit a ſhort proof.

" By the nature of the *Chaldean* tongue moſt words ended in the firſt long vowel like *ſhemià*, Heaven; and that very word, unaltered in a ſingle letter, we find in the *Pazend*, together with *lailià*, night, *meyà*, water, *nírà*, fire, *matrà*, rain, and a multitude of others, all *Arabick* or *Hebrew*, with a *Chaldean* termination. So *zamar*, by a beautiful metaphor from *pruning trees*, means in *Hebrew* to *compoſe verſes*; and thence, by an eaſy tranſition, to *ſing* them: and in *Pahlavì*, we ſee the verb *zamrúniten*, to *ſing*, with its forms *zamrúnemi*, I ſing, and *zamrúníd*, he ſang; the verbal terminations of the *Perſian* being added to the *Chaldaick* root. Now all thoſe words are integral parts of the language, not adventitious to it, like the *Arabick* nouns and verbals engrafted on modern *Perſian*; and this diſtinction convinces me, that the dialect of the *Gabrs*, which they pretend to be that of ZERA'TUSHT, and of which BAHMAN gave me a variety of written ſpecimens, is a late invention of their Prieſts, or ſubſequent at leaſt to the *Muſelman* invaſion. For, although it may be poſſible, that a few of their ſacred books were preſerved, as he uſed to aſſert, in ſheets of lead or copper at the bottom of wells, near *Yezd*, yet as the conquerors had not only a ſpiritual, but a political intereſt in perſecuting a warlike, robuſt, and indignant race of irreconcileable conquered ſubjects, a long time muſt have elapſed before the hidden ſcriptures could have been ſafely brought to light; and few who could perfectly underſtand them, muſt then have remained: but, as they continued to profeſs among themſelves the religion of their forefathers, it became expedient for the *Mubeds* to ſupply the loſt or mutilated works of their legiſlator by new compoſitions, partly from their imperfect recollection, and partly from ſuch moral and religious knowledge as they gleaned, moſt probably, among the *Chriſtians*, with whom they had an intercourſe. One rule we may fairly eſtabliſh in deciding the queſtion, Whether the books of the modern *Gabrs* were anterior to the invaſion of the *Arabs*? When an *Arabick* noun occurs in them, changed only by the ſpirit of the *Chaldean* idiom, as *wertà* for *werd*, aroſe; *daba* for *dhahab*, gold, or *demàn* for *zemàn*, time, we may allow it to have been ancient *Pahlavì*; but when we meet with verbal nouns or infinitives evidently formed by the rules of *Arabian* grammar, we may be ſure, that the phraſes in which they occur are comparatively modern; and not a ſingle paſſage which BAHMAN produced from the books of his religion would abide this teſt.

" We come now to the language of the *Zend*. And here I muſt impart a diſcovery which I lately made, and from which we may draw the moſt intereſting conſequences. M. ANQUETIL, who had the merit of undertaking a voyage to *India*, in his earlieſt youth, with no other view than to recover the writings of ZERA'TUSHT, and who would have acquired a brilliant reputation in *France*, if he had not ſullied it by his immoderate vanity and virulence of temper, which alienated the good will even of his own countrymen, has exhibited in his work, entitled *Zendáveſtà*, two vocabularies in *Zend* and *Pahlavì*, which he has found in an approved collection of *Rawáyát*, or *Traditional Pieces*, in modern *Perſian*. Of his *Pahlavì* no more needs be ſaid, than that it ſtrongly confirms my opinion concerning the *Chaldaick* origin of that language; but when I peruſed the *Zend* gloſſary, I was inexpreſſibly ſurpriſed to find, that ſix or ſeven words in ten were pure *Sanſcrit*, and even ſome of their inflexions formed by the rules of the *Vyácaran*; as *yuſhmácam*, the genitive plural of *yuſhmad*. Now M. ANQUETIL moſt certainly, and the *Perſian* compiler moſt probably, had no knowledge of *Sanſcrit*; and could not, therefore, have invented a liſt of *Sanſcrit* words: it is, therefore, an authentic liſt of *Zend* words which had been preſerved in books, or by tradition; and it follows, that the language of the *Zend* was at leaſt a dialect of the *Sanſcrit*, approaching perhaps as nearly to it as the *Prácrit*, or other popular idioms, which we know to have been ſpoken in *India* two thouſand years ago.

" From all theſe facts it is a neceſſary conſequence, that the oldeſt diſcoverable languages of *Perſia* were *Chaldaick* and *Sanſcrit*; and that, when they had ceaſed to be vernacular, the *Pahlavì* and *Zend* were deduced from them reſpectively; and the *Pársì* either from the *Zend*, or immediately from the dialect of the *Bráhmans*: but all had, perhaps, a mixture of *Tartarian*; for the beſt lexicographers aſſert, that numberleſs words in ancient *Perſian* are taken from the language of the *Cimmerians*, or the *Tartars* of *Ripchák*: ſo that the *three* families, whoſe lineage we have examined in former diſcourſes, had left viſible traces of themſelves in *Irán*, long before the *Tartars* and *Arabs* had ruſhed from their deſerts, and returned to that very country from which in all probability they originally proceeded, and which the *Hindus* had abandoned in an earlier age, with poſitive commands from their legiſlators to reviſit it no more.

" I cloſe this head with obſerving, that no ſuppoſition of a mere political or commercial intercourſe between the different nations will account for the *Sanſcrit* and *Chaldaick* words which we find in the old *Perſian* tongues; becauſe they are, in the firſt place, too numerous to have been introduced by ſuch means, and, ſecondly, are not the names of exotic animals, commodities, or arts, but thoſe of material elements, parts of the body, natural objects and relations, affections of the mind, and other ideas common to the whole race of man.

" If a nation of *Hindus*, it may be urged, ever poſſeſſed or governed the country of *Irán*, we ſhould find in the very ancient ruins of the temple or palace now called *the Throne of* JEMSHI'D, ſome inſcriptions in *Dévanágarì*, or at leaſt in the characters on the ſtones at *Elephanta*, where the ſculpture is unqueſtionably *Indian*, or in thoſe on the *Staff* of FI'RU'Z SHA'H, which exiſt in the heart of *India*; and ſuch inſcriptions we probably ſhould have found, if that edifice had not been erected after the migration of the *Bráhmans* from *Irán*, and the violent ſchiſm in the *Perſian* religion, of which we ſhall preſently ſpeak: for, although the popular name of the building at *Iſtakhr*, or *Perſepolis*, be no certain proof that it was raiſed in the time of JEMSHI'D, yet ſuch a fact might eaſily have been preſerved by tradition; and we ſhall ſoon have abundant evidence, that the temple was poſterior to the reign of the *Hindu* monarchs. The *cypreſſes*, indeed, which are repreſented with the figures in proceſſion, might induce a reader of the *Shánámah* to believe, that the ſculptures related to the new faith introduced by ZERA'-

Tusht; but as a cypreſs is a beautiful ornament, and as many of the figures appear inconſiſtent with the reformed adoration of fire, we muſt have recourſe to ſtronger proofs, that the *Takhti* Jemshi'd was erected after Cayu'mers. The building has lately been viſited, and the characters on it examined, by Mr. Franklin; from whom we learn, that Niebuhr has delineated them with great accuracy: but without ſuch teſtimony I ſhould have ſuſpected the correctneſs of the delineation; becauſe the *Daniſh* traveller has exhibited two inſcriptions in modern *Perſian*, and one of them from the ſame place, which cannot have been exactly tranſcribed. They are very elegant verſes of Ni'za'mi' and Sadi', *on the inſtability of human greatneſs*; but ſo ill engraved, or ſo ill copied, that if I had not had them nearly by heart, I ſhould not have been able to read them; and M. Rousseau of *Isfahàn*, who tranſlated them with ſhameful inaccuracy, muſt have been deceived by the badneſs of the copy, or he never would have created a new King Wakam, by forming one word of Jim, and the particle prefixed to it. Aſſuming, however, that we may reaſon as concluſively on the characters publiſhed by Niebuhr as we might on the monuments themſelves, were they now before us, we may begin with obſerving, as Chardin had obſerved on the very ſpot, that they bear no reſemblance whatever to the letters uſed by the *Gabrs* in their copies of the *Vendidàd*. This I once urged, in an amicable debate with Bahman, as a proof, that the *Zend* letters were a modern invention; but he ſeemed to hear me without ſurpriſe; and inſiſted that the letters to which I alluded, and which he had often ſeen, were monumental characters never uſed in books, and intended either to conceal ſome religious myſteries from the vulgar, or to diſplay the art of the Sculptor, like the embelliſhed *Cúfick* and *Nágarì* in ſeveral *Arabian* and *Indian* monuments. He wondered, that any man could ſeriouſly doubt the antiquity of the *Pahlavì* letters; and, in truth, the inſcription behind the horſe of *Ruſtan*, which Niebuhr has alſo given us, is apparently *Pahlavì*, and might with ſome pains be decyphered. That character was extremely rude, and ſeems to have been written, like the *Roman* and the *Arabick*, in a variety of hands; for I remember to have examined a rare collection of old *Perſian* coins in the Muſeum of the great Anatomiſt William Hunter, and though I believe the legends to be *Pahlavì*, and had no doubt that they were coins of *Parthian* Kings, yet I could not read the inſcriptions without waſting more time than I had then at command, in comparing the letters, and aſcertaining the proportions in which they ſeverally occurred. The groſs *Pahlavì* was improved be Zera'tusht, or his diſciples, into an elegant and perſpicuous character, in which the *Zendáveſtà* was copied; and both were written from the right hand to the left like other *Chaldaick* alphabets, for they are manifeſtly both of *Chaldean* origin; but the *Zend* has the ſingular advantage of expreſſing all the long and ſhort vowels, by diſtinct marks, in the body of each word, and all the words are diſtinguiſhed by full-points between them; ſo that if modern *Perſian* were unmixed with *Arabick*, it might be written in *Zend* with the greateſt convenience, as any one may perceive by copying in that character a few pages of the *Shánámah*. As to the unknown inſcriptions in the palace of Jemshi'd, it may reaſonably be doubted, whether they contain a ſyſtem of letters which any nation ever adopted. In *five* of them, the letters, which are ſeparated by points, may be reduced to forty, at leaſt I can diſtinguiſh no more eſſentially different; and they all ſeem to be regular variations and compoſitions of a ſtraight line and an angular figure, like the head of a javelin, or a leaf (to uſe the language of botaniſts) *hearted and lanced*. Many of the *Runick* letters appear to have been formed of ſimilar elements; and it has been obſerved, that the writings at *Perſepolis* bear a ſtrong reſemblance to that which the *Iriſh* call *Ogham*. The word *Agam*, in *Sanſcrit*, means *myſterious knowledge*; but I dare not affirm, that the two words had a common origin; and only mean to ſuggeſt, that if the characters in queſtion be really alphabetical, they were probably ſecret and ſacerdotal; or a mere cypher, perhaps, of which the prieſts only had a key. They might, I imagine, be decyphered, if the language were certainly known; but in all the other inſcriptions of the ſame ſort, the characters are too complex, and the variations of them too numerous, to admit an opinion, that they could be ſymbols of articulate ſound; for even the *Nágarì* ſyſtem, which has more diſtinct letters than any known alphabet, conſiſts only of forty-nine ſimple characters, two of which are mere ſubſtitutions, and four of little uſe in *Sanſcrit*, or in any other language; while the more complicated figures, exhibited by NIEBUHR, muſt be as numerous at leaſt as the *Chineſe* keys, which are the ſigns of ideas only, and ſome of which reſemble the old *Perſian* letters at *Iſtakhr*: the *Daniſh* traveller was convinced, from his own obſervation, that they were written from the left hand, like all the characters uſed by *Hindu* nations. But I muſt leave this dark ſubject, which I cannot illuminate, with a remark formerly made by myſelf, that the ſquare *Chaldaick* letters, a few of which are found in the *Perſian* ruins, appear to have been originally the ſame with the *Dévanágarì*, before the latter were encloſed, as we now ſee them, in angular frames.

II. The primeval religion of *Irán*, if we rely on the authorities adduced by *Mohſani Fání* was, the belief of one ſupreme God, who created the world, and governs it by his providence; the pious adoration of him; reverence for parents and the aged; fraternal affection for the whole human race, and tenderneſs even for the brute creation. This pure and ſublime ſyſtem could hardly be of long duration; accordingly, we learn from the *Dabiſtán*, that the popular worſhip among the *Iránians* under HU'SHANG was purely *Sabian*. In this work there is a deſcription of the ſeveral Perſian temples dedicated to the ſun and planets, of the images adored in them, and of the proceſſions to them on feſtivals, one of which is probably repreſented by ſculpture in the ruined city of *Jemſhíd*. But the planetary worſhip in Perſia ſeems only part of a far more complicated religion which we now find in the Indian provinces; for *Mohſan* aſſures us, that in the opinion of the beſt informed Perſians who profeſſed the faith of HU'SHANG, the firſt monarch of *Irán* and of the whole earth was MAHA'BA'D, a word apparently *Sanſcrit*, who divided the people into four orders, the religious, the military, the commercial, and the ſervile; to which he aſſigned names unqueſtionably the ſame in their origin with thoſe now applied to the four primary claſſes of the Hindus. They added, that he received from the Creator, and promulgated a ſacred book in a heavenly language, and that fourteen MAHA'BA'DS had appeared or would appear in human ſhapes for the government of this world. This is ſo ſimilar to the belief of the Hindus reſpecting their fourteen MENU'S, and the ſacred book left by the firſt of them, that we can hardly doubt that the firſt corruption of the old and pure religion was the ſyſtem of Indian theology invented by the *Bráhmans*. The acceſſion of CAYUMERS to the throne of Perſia in the eighth or ninth century before Chriſt, ſeems to have been accompanied by a conſiderable revolution in government and religion. He perhaps began the new ſyſtem of national faith which HU'SHANG completed; but the reformation was partial, for while they rejected the complex polytheiſm of their predeceſſors, they retained the laws of *Mahábád*, with a ſuperſtitious veneration for the ſun, the planets, and fire. ZERA'TUSHT reformed the old religion by the addition of genii, or angels, preſiding over months and days; of new ceremonies in the veneration ſhown to fire; of a new work which he pretended to have received from heaven; and, above all, by eſtabliſhing the direct adoration of one Supreme Being. He was born, according to *Mohſan*, in the diſtrict of *Rai*, and travelled into India that he might receive inſtruction from the *Bráhmans*. This reformed religion of Perſia continued in force till that country was ſubdued by the Muſelmans; and without ſtudying the *Zend*, we have ample information concerning it in the writings of ſeveral modern Perſians who profeſſed it.

"With the religion of the old *Perſians* their *philoſophy* (or as much as we know of it) was intimately connected; for they were aſſiduous obſervers of the luminaries, which they adored and eſtabliſhed, according to MOHSAN, who confirms, in ſome degree, the fragments of BEROSUS, a number of artificial cycles with diſtinct names, which ſeem to indicate a knowledge of the period in which the equinoxes appear to revolve: they are ſaid alſo to have known the moſt wonderful powers of nature, and thence to have acquired the fame of magicians and enchanters. But I will only detain you with a few remarks on that metaphyſical theology which has been profeſſed immemorially by a numerous ſect of *Perſians* and *Hindus*, was carried in part into *Greece*, and prevails even now among the learned *Muſelmans*, who ſometimes avow it without reſerve. The modern philoſophers of this perſuaſion are called *Súfis*, either from the *Greek* word for a *ſage*, or from the *woollen* mantle which they uſed to wear in ſome provinces of *Perſia*. Their fundamental tenets are, that nothing exiſts abſolutely but GOD; that the human ſoul is an emanation from his eſſence, and, though divided for a time from its heavenly ſource, will be finally re-united with it; that the higheſt poſſible happineſs will ariſe from its re-union; and that the chief good of mankind, in this tranſitory world, conſiſts in as perfect an *union* with the Eternal Spirit as the incumbrances of a mortal frame will allow; that, for this purpoſe, they ſhould break all *connection* (or *taálluk*, as they call it) with extrinſic objects, and paſs through life without *attachments*, as a ſwimmer in the ocean ſtrikes freely without the impediment of clothes; that they ſhould be ſtraight and free as the cypreſs, whoſe fruit is hardly perceptible, and not ſink under a load like fruit-trees *attached* to a trellis; that if mere earthly charms have power to influence the ſoul, the *idea* of celeſtial beauty muſt overwhelm it in extatic delight; that, for want of apt words to expreſs the divine perfections and the ardour of devotion, we muſt borrow ſuch expreſſions as approach the neareſt to our ideas, and ſpeak of *Beauty* and *Love* in a tranſcendant and myſtical ſenſe; that like a *reed* torn from its native bank, like *wax* ſeparated from its delicious honey, the ſoul of man bewails its diſunion with *melancholy muſic*, and ſheds burning tears, like the lighted taper, waiting paſſionately for the moment of its extinction, as a diſengagement from earthly trammels, and the means of returning to its Only Beloved. Such in part (for I omit the minuter and more ſubtile metaphyſics of the *Súfis*, which are mentioned in *The Dabiſtàn*) is the wild and enthuſiaſtic religion of the modern *Perſian* poets, eſpecially of the ſweet HA'FIZ and the great *Maulavì*: ſuch is the ſyſtem of the *Védánti* philoſophers and beſt lyric poets of *India*; and as it was a ſyſtem of the higheſt antiquity in both nations, it may be added to the many other proofs of an immemorial affinity between them."

III. and IV. On the ancient *monuments* of Perſian ſculpure and architecture, the preſident has nothing to add to the obſervations already made; and as to the *ſciences* and *arts* of the old Perſians, no complete evidence of them is found to exiſt.

"Thus has it been proved, by clear evidence and plain reaſoning, that a powerful monarchy was eſtabliſhed in *Iràn* long before the *Aſſyrian*, or *Píſhdádì*, government; that it was in truth a *Hindu* monarchy, though if any chuſe to call it *Cuſian*, *Caſdean*, or *Scythian*, we ſhall not enter into a debate on mere names; that it ſubſiſted many centuries; and that its hiſtory has been ingrafted on that of the *Hindus*, who founded the monarchies of *Ayódhyà* and *Indrapreſtha*; that the language of the firſt *Perſian* empire was the mother of the *Sanſcrit*, and conſequently of the *Zend* and *Parſi*, as well as of *Greek*, *Latin*, and *Gothick*; that the language of the *Aſſyrians* was the parent of *Chaldaick* and *Pahlavi*; and that the primary *Tartarian* language alſo had been current in the ſame empire; although, as the *Tartars* had no books, or even letters, we cannot with certainty trace their unpoliſhed and variable idioms. We diſcover therefore in *Perſia*, at the earlieſt dawn of hiſtory, the three diſtinct races of men, whom I deſcribed on former occaſions, as poſſeſſors of *India*, *Arabia*, and *Tartary*; and whether they were collected in *Iràn* from diſtant regions, or diverged from it, as from a common center, we ſhall eaſily determine by the following conſiderations.

"Let us obſerve in the firſt place the central poſition of *Iràn*, which is bounded by *Arabia*, by *Tartary*, and by *India*; whilſt *Arabia* lies contiguous to *Iràn* only, but is remote from *Tartary*, and divided even from the ſkirts of *India* by a conſiderable gulf; no country, therefore, but *Perſia* ſeems likely to have ſent forth its colonies to all the kingdoms of *Aſia*. The *Bráhmans* could never have migrated from *India* to *Iràn*, becauſe they are expreſsly forbidden by their oldeſt exiſting laws to leave the region which they inhabit at this day; the *Arabs* have not even a tradition of an emigration into *Perſia* before MOHAMMED, nor had they indeed any inducement to quit their beautiful and extenſive domains: and as to the *Tartars*, we have no trace in hiſtory of their departure from their plains and foreſts till the invaſion of the *Medes*, who, according to etymologiſts, were the ſons of MADAI; and even they were conducted by princes of an *Aſſyrian* family. The *three* races therefore, whom we have already mentioned (and more than three we have not yet found), migrated from *Iràn*, as from their common country. And thus the *Saxon* chronicle, I preſume from good authority, brings the firſt inhabitants of *Britain* from *Armenia*; while a late very learned writer concludes, after all his laborious reſearches, that the *Goths* or *Scythians* came from *Perſia*; and another contends with great force, that both the *Iriſh* and old *Britons* proceeded ſeverally from the borders of the *Caſpian*; a coincidence of concluſions from different media, by perſons wholly unconnected, which could ſcarce have happened, if they were not grounded on ſolid principles. We may therefore hold this propoſition firmly eſtabliſhed, That *Iràn*, or *Perſia* in its largeſt ſenſe, was the true center of population, of knowledge, of languages, and of arts; which, inſtead of travelling weſtward only, as it has been fancifully ſuppoſed, or eaſtward, as might with equal reaſon have been aſſerted, were expanded in all directions to all the regions of the world in which the *Hindu* race had ſettled under various denominations. But, whether *Aſia* has not produced other races of men diſtinct from the *Hindus*, the *Arabs*, or the *Tartars*, or whether any apparent diverſity may not have ſprung from an intermixture of thoſe three in different proportions, muſt be the ſubject of a future enquiry.

IV. *A Letter from Henry Vanſittart, Eſq; to the Preſident.*

MR. Vanſittart ſays, that having met with a Perſian abridgement of the *Aſrárúl Aſághina*, or the ſecrets of the Afghans, a book written in the *Puſhto* language, he was induced to tranſlate it. He does not offer it as a ſerious or probable hiſtory, yet conceives that it may be intereſting.

On the Deſcent of the Afghans from the Jews.

THE *Afghans* according to their own traditions are the poſterity of *Melic Tálút* (king Saul) who according to ſome was a deſcendant of *Judah*, and to others of *Benjamin*. In a war between the Iſraelites and Amalekites, the latter took the ark of the covenant, which, conſidering as the God of the Jews, they endeavoured to deſtroy, but without effect. At this period *Malic Tálút* was anointed king, and had two ſons one called *Berkia*, the other *Irmia*. The ſon of *Berkia* was called *Afghan*, he uſed to make excurſions to the mountains, where his progeny after his death, eſtabliſhed themſelves, lived in a ſtate of independence, and exterminated the infidels. When *the ſelect of creatures*, *Muhammed* appeared upon earth, the Afghans ſought him under their leaders, the ſons of Walid, and the prophet honoured them with his enſign.

Theſe people increaſed ſo much that the army of Sultan Mahmúd was chiefly compoſed of Afghans. They now began to eſtabliſh themſelves in the mountains, and ſome ſettled in cities, dividing themſelves into four claſſes: 1. the *pure*, whoſe fathers and others were both Afghans: 2. thoſe whoſe fathers only were Afghans, 3. thoſe whoſe mothers only were Afghans, and, 4. thoſe who were children of women whoſe mothers only were Afghans.

Shiha ábuddín Gauri, ſultan of *Gaznah*, engaged them in his ſervice, they conquered for him *Delhi*, and in return he gave them the title of *Patans*, from the word *Paitná*, to ruſh.

The race of *Afghans* poſſeſſed themſelves of the mountain of *Solomon* near *Kandahar*; and many monarchs of that race have ſat on the throne of *Delhi*, and ſome of *Gaur*.

To this Mr. Vanſittart adds, that the country of the Afghans, which is a province of Cabul, was originally called *Roh*, from whence is derived the name of *Rohilla*. The city eſtabliſhed in it by the Afghans was called by them *Paiſhwer* or *Paiſhor*, and is now the name of the whole diſtrict. The ſects of the *Afghans* or *at Pâtans*, are very numerous. They are *Muſelmans* partly of the *Sunni*, and partly of the *Shiah* perſuaſion. They boaſt much of the antiquity of their original, but the Muſelmans conſider them as moderns and baſe.

[Mr. Vanſittart has ſubjoined a ſpecimen of the *Puſhto* language.]

To this paper, the preſident has added a note, in which he obſerves, that this account of the Afghans may lead to a very intereſting diſcovery. *Eſdras* ſays the ten tribes came to a country called *Arſareth*, where we may ſuppoſe they ſettled; the *Perſian* hiſtorians ſay the *Afghans* are deſcended from the *Jews*, and they have ſuch a tradition among themſelves, although ſince their converſion to the *Iſlám*, they ſtudiouſly endeavour to conceal their origin. It is even ſaid their families are diſtinguiſhed by the names of Jewiſh tribes. The *Puſhto* language has a manifeſt reſemblance to the Chaldaick, and a conſiderable diſtrict under their domion is called *Hazáreh* or *Hazáret*, which may eaſily be changed from the word uſed by *Eſdras*. The preſident recommends an enquiry into the literature and hiſtory of theſe people.

V. *Re-*

V. *Remarks on the Iſland of Hinzuan or Johanna.*

HINZU'AN (a name which has been gradually corrupted into *Anzuame*, *Anjuan*, *Juanny*, and *Johanna*) has been governed about two centuries by a colony of Arabs, and exhibits a curious inſtance of the ſlow approaches of a ſmall community towards civilization, when it has but few means for improving its natural advantages. An account of this *African* iſland, in which are found the language and manners of *Arabia*, appeared to the preſident, who touched at it in his voyage to India in 1783, worthy of being laid before the ſociety. But as it is drawn up in the form of a mere traveller's narrative, and contains nothing of a ſcientific or literary kind which we can extract for the information of our readers, we ſhall content ourſelves with pointing out its title and ſubject.

VI. *On the Baya, or Indian Groſs-Beak.* *By* AT'HAR ALI' KHA'N, *of Dehli.*

THE little bird, called *Bayá* in *Hindì*, *Berbera* in *Sanſcrit*, *Bábùi* in the dialect of *Bengal*, *Cíbù* in *Perſian*, and *Tanawwit* in *Arabick*, from his remarkably *pendent* neſt, is rather larger than a ſparrow, with yellow-brown plumage, a yellowiſh head and feet, a light-coloured breaſt, and a conic beak very thick in proportion to his body. This bird is exceedingly common in *Hinduſtàn:* he is aſtoniſhingly ſenſible, faithful, and docile, never voluntarily deſerting the place where his young were hatched, but not averſe, like moſt other birds, to the ſociety of mankind, and eaſily taught to perch on the hand of his maſter. In a ſtate of nature he generally builds his neſt on the higheſt tree that he can find, eſpecially on the palmyra, or on the *Indian* fig-tree, and he prefers that which happens to overhang a well or a rivulet: he makes it of graſs, which he weaves like cloth and ſhapes like a large bottle, ſuſpending it firmly on the branches, but ſo as to rock with the wind, and placing it with the entrance downwards to ſecure it from birds of prey. His neſt uſually conſiſts of two or three chambers; and it is the popular belief, that he lights them with fire-flies, which he catches alive at night and confines with moiſt clay, or with cow-dung: that ſuch flies are often found in his neſt, where pieces of cow-dung are alſo ſtuck, is indubitable; but, as their light could be of little uſe to him, it ſeems probable that he only feeds on them. He may be taught with eaſe to fetch a piece of paper, or any ſmall thing, that his maſter points out to him: it is an atteſted fact, that if a ring be dropped into a deep well, and a ſignal given to him, he will fly down with amazing celerity, catch the ring before it touches the water, and bring it up to his maſter with apparent exultation; and it is confidently aſſerted, that, if a houſe or any other place be ſhown to him once or twice, he will carry a note thither immediately on a proper ſignal being made. One inſtance of his docility I can myſelf mention with confidence, having often been an eye witneſs of it: the young *Hindu* women at *Banáres* and in other places wear very thin plates of gold, called *tíca's*, ſlightly fixed by way of ornament between their eye-brows; and, when they paſs through the ſtreets, it is not uncommon for the youthful libertines, who amuſe themſelves with training *Bayá's*, to give them a ſign which they underſtand, and ſend them to pluck the pieces of gold from the foreheads of their miſtreſſes, which they bring in triumph to the lovers. The *Bayà* feeds naturally on graſs-hoppers and other inſects, but will ſubſiſt, when tame, on pulſe macerated in water: his fleſh is warm and drying, of eaſy digeſtion, and recommended, in medical books, as a ſolvent of ſtone in the bladder or kidneys; but of that virtue there is no ſufficient proof. The female lays many beautiful eggs reſembling large pearls; the white of them, when they are boiled, is tranſparent, and the flavour of them is exquiſitely delicate. When many *Bayàs* are aſſembled on a high tree, they make a lively din, but it is rather chirping than ſinging; their want of muſical talents is, however, amply ſupplied by their wonderful ſagacity, in which they are not excelled by any feathered inhabitants of the foreſt.

VII. *On the Chronology of the Hindus. Writtin in January* 1788.

THE preſident's purpoſe in this diſſertation is to lay before the ſociety a conciſe account of Indian chronology, extracted from *Sanſcrit* books, or collected from converſations with *Pandits*, and to ſubjoin a few remarks on their ſyſtem. He begins with copying from one of the books in *Sanſcrit*, an arrangement of infinite time, as divided into days and years of men, of the Gods, and of BRAHMA; which the Hindus underſtand literally, but which bears intrinſic marks of being purely aſtronomical. It may therefore be rejected from an enquiry into the hiſtorical or civil chronology of India. Without going over the particulars of their fanciful calculations, it may ſuffice to ſtate, that according to the Hindu reckoning, we are now in the firſt day, of the firſt month, of the 51ſt year of BRAHMA's age; and in the 28th divine age of the ſeventh *Manwantara*; of which divine age, the three firſt human ages have paſſed, and 4888 years of the fourth.

In the time of the ſeventh MENU, (or heaven-born ſovereign of the earth) ſurnamed VAIVASWATA, or *Child of the Sun*, the Hindus believe the whole earth to have been drowned, and all the human race deſtroyed, except the pious prince himſelf, and ſeven *Riſhis* or holy perſons and their wives. From this MENU the whole race of men is believed to have deſcended; for the ſeven *Riſhi's* are not mentioned as fathers of families. But ſince his daughter ILA' was married to the firſt BUDDHA or *Mercury*, the ſon of CHANDRA, or the Moon, his poſterity are divided into two great branches, called the *Children of the Sun*, from his own ſuppoſed father, and the *Children of the Moon*, from the parent of his daughter's huſband. The lineal male deſcendants of both theſe families are ſuppoſed to have reigned in the cities of *Ayódhyà* or *Audh*, and *Pratiſht'hána*, or *Vitóra*, reſpectively till the thouſandth year of the preſent age. Their names collected from ſeveral *Purána's*, are exhibited by the preſident in two columns arranged by himſelf. They amount to fifty ſix *of the Sun*, ending in RAMA, and forty ſix *of the Moon*, ending in *Yudhiſht'hir*. This is called the *ſecond age*. By means of the uſual calculations applied to lines of princes, the extravagant numbers given in Hindu chronology are corrected. RAMA is ſuppoſed to have lived about three thouſand eight hundred years ago.

The *third age* brings down the children of the Sun, through thirty deſcents, to *Vrihadrana*; and thoſe of the Moon, to *Paricſhit*. The *fourth age* has twenty nine perſons in each line, in the laſt of whom theſe dynaſties are ſuppoſed to have became extinct. Then follow liſts of the kings of *Magadha*, of *Maurya*, *Sunga*, *Canna*, and

Andhra kings. From the whole, the two following propoſitions are laid down a indubitable; that the *three firſt* ages of the Hindus are chiefly *mythological,* whether their mythology was founded on the dark enigmas of their aſtronomers, or on the heroic fictions of their poets; and that the *fourth* or *hiſtorical* age cannot be carried farther back than about two thouſand years before Chriſt. The ſubject is however ſo obſcure, and ſo much clouded by fictions of the Brahmans, who have through vanity extended their antiquity, that we muſt be ſatisfied with probable conjectures, unleſs the aſtronomical books in Sanſcrit ſhall clearly aſcertain the places of the colures in ſome preciſe years of the hiſtorical age. The preſident concludes with A Chronological Table *according to one of the Hypotheſes intimated in the preceding Tract.*

Christian *and* Muselman.	Hindu.	*Years from* 1788 *of our era.*
Adam,	Menu I. Age I.	5794
Noah,	Menu II.	4737
Deluge,		4138
Nimrod,	*Hiranyacaſipu.* Age II.	4006
Bel,	*Bali,*	3892
Rama,	Rama. Age III.	3817
Noah's death,		3787
	Pradyóta,	2817
	Buddha. Age IV.	2815
	Nanda,	2487
	Balin,	1937
	Vacramáditya,	1844
	Dévapála,	1811
Christ,		1787
	Náráyanpála,	1721
	Sacá,	1709
Walíd,		1080
Mahmúd,		786
Chengiz,		548
Taimúr,		391
Babur,		276
Nádirſháh,		49

We have given a very abridged view of this elaborate paper, which abounds in particular and deſultory remarks and calculations in ſuch a manner as to be abſolutely incapable of analyſis. Nor do we ſuppoſe our readers will be ſo much intereſted in the confutation of the wild and abſurd fancies of the Hindus, as in the reſults which ingenious criticiſm has drawn from the veſtiges of truth which they appeared to contain.

On the Cure of the Elephantiaſis. *By* At'har Ali' Kha'n *of Dehli.*

In an introductory note, it is ſaid that this diſeaſe is the *judhám* of the Arabs, or *khórah* of the Indians; that in Arabia it is alſo called *dáül'áſad,* a name correſponding with the *Leontiaſis* of the Greeks. Hillary, in his obſervations on the diſeaſes of Barbadoes, calls it the *Leproſy of the Joints*, becauſe it principally affects the extremities, which in the laſt ſtage become diſtorted, and at length drop off. But as it is really a corruption of the whole maſs of blood, it requires a general appellation, and may be properly named the *Black Leproſy*, which name has been adopted by Sauvages and Gorrœus, in contradiction to the *White Leproſy*. This diſeaſe is peculiar to hot climates, and has rarely appeared in Europe. It has been imported from Africa by the negroes into the Weſt India iſlands; but it has been long known in Hinduſtan, and rages with virulence among the native inhabitants of Calcutta. Mercury has been found ineffectual in the cure, or rather hurtful. The juice of hemlock, which has been propoſed, does not ſeem to be a medicine of ſufficient power in an inveterate caſe.

The writer of the *Diſſertation* came with his father, who was phyſician to Nadirſhah, from Perſia to Dehli. The receipt was communicated to him in 1783, by Mír Muhammed Huſaín, when he accompanied Mr. Richard Johnſon from Lachnau to Calcutta, as a moſt powerful remedy againſt all corruptions of the blood, leprous, and venereal. It is an old ſecret of the Hindu phyſicians, who applied it alſo to the cure of cold and moiſt diſtempers, as the palſy, diſtortions of the face, relaxations of the nerves, and ſimilar diſeaſes. It is thus prepared. "Take of *white arſenic*, fine and freſh, one tólá; of picked black pepper ſix times as much: let both be well beaten at intervals for four days ſucceſſively in an iron mortar, and then reduced to an impalpable powder in one of ſtone with a ſtone peſtle, and thus completely levigated, a little water being mixed with them. Make pills of them as large as tares or ſmall pulſe, and keep them dry in a ſhady place. One of theſe pills muſt be ſwallowed morning and evening with ſome *betel*-leaf, or in countries where betel is not at hand, with cold water: if the body be cleanſed from foulneſs and obſtructions by gentle cathartics and bleeding before the medicine is adminiſtered, the remedy will be ſpeedier." It appears from a note that the tólá weight is equal to 105 grains troy; but the weight of the whole maſs is of little conſequence, ſince the ſingle doſes are left ſo indeterminate. The writer goes on to mention the qualities of white and yellow arſenic. He obſerves that the beſt antidote againſt the poiſonous effects of arſenic, is the ſcrapings of leather reduced to aſhes. Four times as much of them as of the arſenic, mixed with water and drank, will counteract the poiſon.

The writer prepared and adminiſtered the receipt in various of the above-mentioned diſeaſes, to numbers who were almoſt at the point of death, and he calls God to witneſs that they were all completely cured. One was a Párſì, ſo cruelly afflicted with a confirmed lues, here called the *Perſian fire*, that his extremities was all ulcerated and almoſt rotted off. He was perfectly recovered after taking the *arſenic-pills* a fortnight. But its power was chiefly tried in the cure of the *judhám*, or *juzám*, as the word is pronounced in India. This diſeaſe he deſcribes as extremely contagious, and alſo hereditary. A common cauſe of it, he ſays, is the unwholeſome diet of the natives, who are accuſtomed after eating plentifully of fiſh, to ſwallow large draughts of milk. Other cauſes are alſo mentioned; as particularly the uſe of provocatives. The venereal lues generally ends in this malady. He relates a caſe of a man who being diſordered with the Perſian fire, on cloſing an ulcer, was ſeized with violent pains of the limbs, which were removed by cinnabar pills given him by a Hindu phyſician; but were ſoon ſucceeded by ſymptoms of the *juzám*, which increaſed to the higheſt degree of that diſeaſe.

The firſt ſymptoms of the *juzám* or *elephantiaſis* are, numbneſs and redneſs of the whole body, principally of the face, an impeded hoarſe voice, thin and falling hair, offenſive perſpiration and breath, and whitlows on the nails. The cure is beſt begun with copious bleeding, and cooling drink, ſuch as the decoction of Nymphæa and violets, with ſome doſes of Manna: after which ſtronger cathartics muſt be exhibited. But no remedy has proved ſo effectual as the pills of arſenic and pepper. One caſe of their efficacy, out of many, is ſelected. One *Shaikh Ramazání*, an upper ſervant to the board of revenue, had a corruption of the blood, denoted by beginning ulceration of his limbs, and other ſymptoms of a confirmed juzám. After copious bleeding and other preparation, he began the pills. After the firſt week the malady ſeemed alleviated; in the ſecond it was conſiderably diminiſhed; in the third, entirely removed. No particulars are given of the operation and ſenſible effects of the medicines.

IX. *On the Indian Game of Cheſs. By the* PRESIDENT.

THE preſident ſays, if evidence be required to prove that the game of cheſs was invented by the *Hindus*, we may be ſatisfied with the teſtimony of the Perſians, who unanimouſly agree that it was imported from the Weſt of India, in the ſixth century of our era. It is known at Hinduſtan by the name of *Chaturanga*, that is the four anga's, or members of an army, viz. *elephants*, *horſes*, *chariots* and *foot ſoldiers*, by a natural corruption, it is changed by the Perſians into *Chatrang* and the Arabs altered it to *Shatranj*, thus has a very ſignificant word in the Brahmans language, been tranſformed by ſucceſſive changes into *axedres*, *ſcacchi*, *echecs*, and *cheſs*. The beautiful ſimplicity of this game, convinces the preſident that it was invented at once, and not formed by gradual improvements, yet he cannot find any account of it in the writings of the Brahmans. There is an Indian game of the ſame kind, called alſo *Chaturanga*, but more frequently *Chaturaji* or the *four kings*, played by four perſons, and repreſenting as many princes and two allied armies combating on each ſide the board; it conſiſts like ours of ſixty-four ſquares, half occupied by the men and half vacant. The preſident was informed that the Brahmans of Bengal were once celebrated for their ſkill in this game. Some of the principal rules of the game are, Firſt, when one king has placed himſelf in the ſquare of another king he wins the ſtake, which is doubled if he kills the adverſe monarch. Secondly, if he can occupy ſucceſſively the place of the three princes, he obtains the victory. Thirdly, when one player has his king on the board, but his partner's king has been taken, if he can ſeize the adverſe kings he may exchange one. Fourth, if a pawn can march to the oppoſite extremity of the board, it aſſumes the power of that ſquare. Fifthly, if a king is left on the plain without force, there is neither victory nor defeat.

X. *Two Inſcriptions from the Vindhya Mountains, tranſlated from the Sanſcrit, by* CHARLES WILKINS, *Eſq.*

THE firſt of theſe inſcriptions is in a cavern called the Grot of the ſeven Riſhi's, near Gaya, and is to the honour of Kreeſhna, the ſecond is in a Cave behind Nagarjeni, and is to the honour of Bhootapatee and of Devee.*

XI. A

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* A type of the deities Genitor and Genitrix.

XI. *A Deſcription of Aſam, by Mohammed Cazim, tranſlated from the Perſian, by* HENRY VANSITTART, *Eſq.*

ASAM lies north eaſt of Bengal, and is divided into two parts, the northern called Uttarcul, and the ſouthern Dacſhincul; its length is about two hundred ſtandard cos, and its breadth about eight days journey. It is watered by the river Brahma-Putra, which flows from Khata, and ſeveral rivers that run into it, the principal of theſe is the Dhonac, the land between them is ſpacious and clear, and bounded by a thick foreſt abounding with elephants, in this and other foreſts of Aſâm, five or ſix hundred elephants may be procured in a year. Acroſs the Dhonac the country is marked with population and tillage, and preſents on every ſide charming proſpects, ploughed fields, gardens, and groves. As the country is overflowed in the rainy ſeaſon, a cauſeway is raiſed for the convenience of travellers, and on each ſide is planted ſhady bamboos, the top of which meet and intertwine. The fruits produced here are mangoes, plantanes, oranges, citrons, limes, &c. The ſugar cane excels in ſweetneſs, and is of three colours, red, black and white.

The ſilks here are excellent, and reſemble the Chineſe, ſalt is a ſcarce commodity. The mountains are inhabited by the tribe called *Nanacs*, an evil diſpoſed race, who go naked, and eat dogs, cats, mice, locuſts, and any thing they can find.

The country of Uttarcul is in a high ſtate of cultivation, the inhabitants of theſe mountains are ſtrong, and have a reſpectable appearance, their complexions are red and white. Gold and ſilver are procured in Aſâm, by waſhing the ſand of the rivers. This is one ſource of revenue, and it is ſuppoſed that 20,000 people are employed in this occupation. The people of Aſâm are baſe and unprincipled, have no fixed religion, nor any rule but their inclinations, they eat all fleſh except human, and will eat animals that die a natural death. The women are not veiled, and perform work in the open air. The men have often four or five wives, whom they publicly buy, ſell and exchange. They ſhave their heads and beards, their ſtrength and courage are apparent in their looks, and their ferocious tempers betrayed by their phiſiognomy. They are enterprizing, ſavage, fond of war, vindictive and deceitful, their dreſs conſiſts of a cloth round their heads, another round their loins, and a ſheet over their ſhoulders; both rich and poor conſtruct their habitations of wood, bamboos and ſtraw. The Raja and his courtiers travel in litters, and opulent perſons in doolies. Aſâm has neither horſes, camels, nor aſſes, but they are ſometimes brought there from other countries, aſſes they are fond of, but are ſo much afraid of a horſe, that one trooper would put an hundred of them to flight.

The ancient inhabitants of this country are divided into two tribes, the *Aſamians*, and *Cultanians*, the former are the warriors, of which ſix or ſeven thouſand attend the Raja as a body guard, their martial weapons are the muſquet, ſword, ſpear, arrow and bow, they have alſo cannon and ſwivels, in the uſe of which they are very expert.

On the death of any of the Raja's they dig a cave for the deceaſed, in which they inter his women, attendants and ſervants, and ſome of his magnificent equipage and furniture, ſuch as elephants, gold and ſilver, carpets, cloaths, victuals, lamps, with a great deal of oil, and a torch bearer, for they conſider theſe things as neceſſary in a future ſtate; they afterwards cover the cave with a roof of ſtrong timbers. The people of the army entered ſome of theſe caves, and took out of them the value of ninety thouſand rupees in gold and ſilver.

Ghergong, where the Rajah's palace is ſituated, has four gates, has a fence of bamboos, and raiſed cauſeways for the convenience of paſſengers in rainy ſeaſons; before each houſe is a garden, and ſome cultivated ground. The Rajah's palace is ſurrounded with a ditch, and has within it ſome ſpacious apartments, among which is a *dīwān khānah*, or public ſaloon, one hundred and fifty cubits long, forty broad, and is ſupported by ſixty ſix wooden pillars. There are here many plates of braſs ſo well poliſhed as to ſhine like mirrors.

The Rajahs diſplay an oſtentatious appearance of grandeur, they have never paid tribute to any, and have checked the conqueſt of ſome of the moſt victorious princes of Hinduſtan. Covered in their ſtrong poſts, they diſtreſs their enemy by ſtratagems, ſurprizes and alarms, and when the rainy ſeaſons ſets in, they fall on their invaders, and have in this manner deſtroyed numerous armies.

Huſain Shàh, king of Bengal, loſt a large army in this manner. Mohammed, ſon of Togluc Shàh, had an army of 100,000 men deſtroyed in an invaſion of this country.

XII. *On the Manners, Religion and Laws of the Cúci's or Mountaineers of Tipra, communicated by* John Rawlins, *Eſq.*

THE inhabitants of the mountainous diſtricts eaſt of Bengal, give the name Pàtiyàn, to the Being, who created the univerſe, but they believe that a deity exiſts in every tree, and that the ſun and moon are gods. If any one of them kills another, the brother or heir only have a right to take blood for blood; ſmaller crimes are puniſhed by a fine, directed by the Chieftain. The Cuci cruelly cut off the heads of the women of an enemy's country, even if they are pregnant.

Their wives they purchaſe of the father or mother for cattle; a man may marry any woman except his mother. If a married couple have a ſon, the wife is fixed, but if they have no ſon, the huſband may divorce her.

They have no idea of heaven or hell, or future rewards and puniſhments, but believe that a ſpirit carries away the ſoul of the dying perſon.

Their food conſiſts of elephants, hogs, deer and other animals, and if they find the carcaſſes or limbs in the foreſts, they dry and eat them. When reſolved on war, they march in the night, armed with ſwords, lances and arrows, to ſurprize their enemy, and if they ſucceed, kill all they meet, male and female, and ſtrip the houſes. If they are oppoſed and over-matched, they quickly retreat. If they ſee a ſtar near the moon, they expect an attack from their enemy, and remain under arms. They lay at all times in ambuſh to kill their foes, and he who carries home a head is diſtinguiſhed in his nation. If two parties meet pretty equal, they come to a treaty, which they conclude with feaſting, calling on the ſun and moon to witneſs their pacification. A vanquiſhed tribe becomes tributary to their conquerors. Their proviſions for war is a dried root like a potatoe, with paſte of rice-flour, and having no victuals to dreſs, they march a great diſtance in one day. Their weapons of war are fabricated only by particular tribes.

Their houſhold affairs belong wholly to the women, the men build the huts, cultivate the land, hunt and make war. On the birth of a child they feaſt their friends, and end the day with dancing and ſinging. All deformed perſons go about begging like religious mendicants.

At the death of one of the Cuci, they kill a hog, and having boiled the meat, pour ſome liquor into the mouth of the deceaſed, twiſt a piece of cloth round his body, and all taſte the liquor as an offering to his ſoul, this they repeat ſeveral days. Then lay the body on a ſtage, dry it by a fire and inter it, ſcattering fruits and flowers over the grave; but ſome of them cover their dead with a ſhroud and a mat, and hang them on a high tree. When the fleſh is decayed they waſh the bones, and keep them in a bowl, often conſulting them on any emergency, and alledging that they act by the command of their departed friend. A widow muſt remain a whole year near the grave of her huſband; where the family bring her food. If ſhe die within the year, they mourn for her, if ſhe lives they carry her back, and her relations have an entertainment. If the deceaſed leaves three ſons, the eldeſt and youngeſt take the property, the other has nothing. If he has no ſons, the eſtate goes to his brother, if no brothers, it eſcheats to the chief.

XIII. *On the ſecond Claſſical Books of the Chineſe.* *By the* PRESIDENT.

ACCORDING to a Chineſe writer, named *Li Yang Cing*, the ancient characters uſed in his country were the outlines of viſible objects, earthly and celeſtial, and the grammarians of China tried to repreſent the operations of the mind by metaphors drawn from the productions of nature.

In this language, ſo wonderfully compoſed, there are a multitude of books of uſeful and agreeable knowledge, but the higheſt claſs conſiſts of *five* works, one of which every Chineſe who aſpires to literary honours, muſt be perfectly maſter of. The firſt of theſe books is purely *hiſtorical*, containing annals of the empire for 2337 years before Chriſt: it it entitled Shuking, and a verſion of it has been lately publiſhed in *France*; for to the French we are indebted for the moſt valuable ſpecimens of Chineſe hiſtory and literature. The ſecond claſſical works contains odes or ſhort poems, in praiſe of their ancients, or deſcriptive of ancient manners. They abound in wiſe maxims, and excellent precepts, their doctrine, according to Cun-fu-tſu, is reducible to this, that we ſhould not do any thing baſe or culpable. They are highly commended by that ſage in his Lúnyú, or moral diſcourſes, but are ſuppoſed to be much disfigured ſince the time of that philoſopher. Moſt of theſe odes are three thouſand years old, and ſome the Chineſe ſay are older.

The third book called *Yoking*, or the book of changes, is believed to have been written by Fo, the *Hermes* of the Eaſt, but is ſcarcely intelligible to the moſt learned Mandarins. The fifth book, or *Liki*, conſiſts of the Chineſe ritual, or tracts on moral duties; but the fourth, intitled *Chung Cieu*, or ſpring and autumn, by which it means the flouriſhing ſtate of an empire, under a good king, and the fall of kingdoms under bad governors.

Sir William hints that he expects the tranſlation of a very valuable Chineſe work from Canton, and hopes to be able to procure a complete tranſlation of the Shí King, and an authentic abridgement of the Chineſe laws, civil and criminal. A native of China, *Whang Atong* has promiſed his aſſiſtance, but it appears by a letter from him to the preſident, that the tranſlation of the above book would require three or four years.

XIV. *A Table, containing Examples of all the different Species of Infinitives and Participles that are derived from triliteral Verbs, in the Form in which they are uſed in the Perſian, and in the Language of Hinduſtan.*

This table being of uſe to thoſe only who are acquainted with the two languages, and beſides being very long and incapable of abridgement, we ſhall omit.

XV. *On the Aſtronomical Computations of the Hindus.* By Samuel Davis, *Eſq.*

Dated from Bhágalpur.

THE prediction of eclipſes and other phænomena in the Hindu patra or almanack, excited Mr. Davis to enquire by what means it was performed, and being referred to the Súrya Siddhánta, reputed a divine revelation, and the Tica, or commentary on it, by the rules laid down in them, he calculated the ecipſe for November 1789, and was enabled to inveſtigate the principles of the Hindu aſtronomy.

The Hindu diviſion of the ecliptick into ſigns, degrees, &c. is the ſame as ours. Their aſtronomical year is ſidereal, commencing on the ſun's entrance into Aries, or Méſha, each aſtronomical month containing as many even days and fractional parts, as he ſtays in each ſign, and the civil differs from the aſtronomical account of time in rejecting thoſe fractions, and beginning the year and month at ſun riſe.

The Hindus have framed an epoch for their aſtronomical obſervations from the time when they ſuppoſed that all the planets were in conjunction in the beginning of Aries, or Méſha; from whence alſo they date the creation. From that era 1955884890 years have elapſed, and in 2364115110 years, the planets will be again in the ſame ſituation. Theſe two ſums form the grand period called a Calpa, or day of Brahma. The Calpa is divided into Manwanteras, and greater or leſs Yugas. The uſe of the Manwantera is not ſtated in the Súrya Siddhánta, but the Maha or greater Yúg is the period elapſed from the time, that the moon in its apogee and aſcending node was in conjunction with the ſun in the firſt of Aries, to their return to the ſame ſituation.

Since on the creation the centers of the earth, ſun and planets were in a right line, their mean longitude for any propoſed time is determined by an eaſy proportion. As the number of revolutions of a planet in the cycle, is to the number of days compoſing it, ſo are the given days to the motion in that time. Then caſting out the even revolutions, the remainder ſhews the mean longitude from Lanca, the equinoctial point at midnight.

The following account is taken from the Súrya Siddhánta, written in Sanſcrit. Sidereal time is eſtimated by reſpirations, of which ſix make a Picalà, ſixty Picalà a Danda, ſixty Dandas a Nacſhatra day, and thirty Nacſhatra days a Nacſhatra, or ſidereal month. The Savan month is contained between thirty ſucceſſive riſings of Súrya the ſun, and from its unequal motion in right aſcenſion is variable. Thirty Tithis compoſe the lunar month. In a Saura month the ſun deſcribes one ſign of the Zodiack, his paſſage through the twelve ſigns makes a year, i. e. a Déva day, or day of the Gods. Six times ſixty Deva days make the Deva year, and twelve Deva years form four Yugas. To find the Saura years in theſe Yugas, write down the numbers 4,3,2, and multiply them by 10000, the product 4320000 is the Maha Yúg, Yug, including the Sandhi and Sandhyanſa, the morning and evening twilight. This is divided into four Yugas, from the different proportions of virtue on the earth, in the following manner. Divide 4320000 by 10, and multiply the quotient by four, for the Satya Yug, by three for the Trela, by two for the Dwápar, and one for the Cali Yug, and each of the Yugs by ſix for its Sandhi and Sandhyanſa. Seventy-one Yugs make a Manwantera, at the cloſe of which is a Sandhi, equal to the Satya Yug, when an univerſal deluge prevails. Fourteen Manwanteras, including the Sandhi, compoſe a Calpa, and at the commencement of each Calpa is a Sandhi equal to the Satya Yug, or 1728000 Saura years. There a Calpa is equal to 1000 Maha Yugs. One Calpa is a day, and one a night with Brahma, and he lives 100 years. Fifty years of his life are expired, and of the remainder the firſt Calpa is begun, and ſix Manwanteras, including the Sandhi, are expired. Of the ſeventh Manwantera, named Vaivaſwata, twenty-ſeven Maha Yugs are elapſed, and we are in the Satya Yug of the twenty-eighth. The Satya Yug conſiſts of 1728000 Saura years. Hence the number of years from the commencement of Calpa to the preſent time may be computed, but from the ſum muſt be deducted one hundred times four hundred and ſeventy-four divine years, the time employed by Brahma in the creation of the world.

In one Yug, Surya the ſun, Budha Mercury, Sucra Venus, perform 4320000 Madhyama revolutions through the zodiack. Mangala Mars, Vrihaſpati Jupiter, Sani Saturn, make the ſame number of Sighra revolutions. Chandra the moon makes 57753336 Madhyama revolutions. Mangala 2296832 Madhyama revolutions; Buddha's Sighras are 17937060; Vrihaſpati's Madhyamas 364220; Sucra's Sighras 7022376; Sani's Madyamas 146568. The Chandróhcha, or moon's apogee revolutions, are 488203, the retrograde revolutions of the Chandrapáta, or moon's aſcending nodes, are 232238. × ×

The planetary motions, as above deſcribed, might have ſerved for computations in the time of Meya, the author of the Súrya Siddhánta, but for evident reaſons they have been found for many years not to agree with the obſerved places in the heavens, and corrections in Sanſcrit, called Bija, have been introduced.

The place of the ſun's apogee is 3s..6°..38′..42′. In this the Hindu account differs from the European, which places it in 3s..8°..1′ about 1°22′. There is a much greater diſagreement with reſpect to the aphelia and nodes of the other planets.

Having thus the mean motion of the planets, their nodes and apſides, and the elapſed time ſince they were in conjunction, we may determine their preſent mean longitude; but it is obſerved in the Súrya Siddhánta, that to aſſume ſo long a period is not always neceſſary. For uſe, the computation may be made from the beginning of the Tréta age, when all the moveable points in the heavens, except the apogees and aſcending nodes, which muſt be computed from the creation, were again in conjunction in Méſha. And for the mean longitude of the planets, the Hindu aſtronomers do not now go farther back than the commencement of the Cali Yug.

For the ſolution of triangles neceſſary in the equation of the mean to the true anomaly, a canon of ſines is conſtructed according to the Surya Siddhánta in the following manner. Divide the number of minutes in one ſign by eight, the quotient 225′ is the firſt Jyapuida. Divide the firſt Jyapuida by 225′, the quotient 1′ being deducted, add 224 to it, for the ſecond Jyapuida 449′. Divide this by 225′, the quotient being one of a fraction, deduct two from the foregoing remainder 224, and add the remainder to the ſecond for the third Jyapuida 671. Divide this by 225, deduct the quotient 3 from the laſt remainder 222, add the remainder 219 to the third for the fourth Jyapuida 890, and thus proceed till the twenty-four right ſines are completed. For the verſed ſines, deduct from the 24th the 23d ſine for the firſt verſed ſine, the 22d from the 23d ſine for the ſecond verſed ſine, the 21ſt from the 22d for the third verſed ſine.

The ſine complement of an arc is the ſame as its ſine. The ſquare of the ſine deducted from the ſquare of radius gives the ſquare of the coſine, whoſe root gives the coſine, and in the ſame manner from the coſine, the ſine may be determined, and in other reſpects they proceed according to our method, though it does not appear that they conſtructed their ſines for more than twenty-four diviſions of the quadrant. For the ſines of the intermediate arcs, take a mean proportion of the tabular difference; thus the ſine of 14° exceeds the third tabular arc by 165 minutes, 225 is the difference between the third and fourth tabular arcs, and 219 the difference of their ſines $\therefore \frac{165' \times 219'}{225'} = 160'..36''$ is to be added to the ſine of the third tabular arc for the ſine required. In theſe calculations, when the fraction exceeds half, it is uſually taken as a whole number; thus, $831'..35''..35'''$ would be made $831'..36''$.

The Hindus place the earth in the center of the univerſe, and have recourſe to excentric circles to account for the apparent inequality in the motions of the planets. From the center $\oplus$ deſcribe a circle, in whoſe circumference mark as in the ecliptic, the ſigns, degrees, &c. Through the center draw a diameter to the place of apogee, and between that place and the center take $\oplus E$ equal to the excentricity, which is equal to the ſine of the greateſt anomaliſtic equation. Round E as a center, with radius equal to the former radius, deſcribe another circle, and divide it as the other, according to the ſigns in the ecliptic. Note the mean long in each circle from the apogee, and from both points b and a draw eight lines to the earth at $\oplus$, then $b \oplus H$ is the true anomaly, $a \oplus c$ the mean anomaly, and $a \oplus b$ the equation of the mean to the true place. The Europeans in the old aſtronomy found the angle $b \oplus c$ by means of a table of tangents; but the Hindus having no ſuch invention, proceed in a different manner. Round a the planet's mean place, with radius equal to the excentricity $E \oplus$, draw the circle $e\,d\,g\,f$. In the right angled triangle $c\,b \oplus$ right angled at b, are given the ſides $b \oplus$ ($= a \oplus + c\,b$ becauſe $b\,a = c\,b$) and $b\,c$ to find the hypothenuſe $c \oplus$, from whence the angle $a \oplus m$ may be determined for by ſimilar triangles, as $c \oplus : m \oplus :: b\,c : l\,m$. See Plate IX. Fig. 1, and Fig. 2.

It is only in computing the retrogradations and other particulars, reſpecting the planets Mercury, Venus, Mars, Jupiter, and Saturn, where circles greatly excentric are to be conſidered, that the Hindus find the length of $c \oplus$, in other caſes as for the anomaliſtic equations of the ſun and moon, they take $b\,c$ equal to $l\,m$, their difference being eſteemed inconſiderable.

On this principle the tables of anomaly are computed with the aid of a peculiar adjuſtment. The difference between the mean and obſerved places of the planets in the firſt degree of anomaly from either apſide being greater than could be accounted for by their plan, they enlarged the cycle in apogee and perigee, making it vary inverſely as the ſine of the mean anomaly, the radius of the epicycle being equal at the diſtance of three ſigns to the excentricity or ſine of the greateſt equation. Hence a planet in the three firſt ſigns is ſaid to be in Viſhama, the odd ſigns in the three next in Sama, the even in the three next in Viſhama, and then in Sama. By theſe rules the equation of the mean to the true anomaly and motion for each degree of the quadrant may be found, and they are thus given for the ſun and moon in the tables of Macaranda..

The true longitude of the ſun and moon, and the place of the node being determined by the preceding methods, it is eaſy to judge whether at the next conjunction or oppoſition, there will be a ſolar or a lunar eclipſe, in which caſe the tithi or date of the moon's ſynodical month muſt be computed. Her diſtance in longitude from the ſun, divided by 720′ the minutes in a tithi, ſhews the tithi ſhe has paſſed, and the fraction the part performed of the next, if it is the fifteenth tithi the difference between that fraction and 720′ is the diſtance ſhe has to go to her oppoſition, and thus the middle of the lunar eclipſe will be determined.

It is evident, from theſe calculations, that the aſtronomers of India reject the ridiculous belief of the common Bráhmans, that eclipſes are occaſioned by the intervention of the monſter Rahu; but as this belief is contained in their ſacred books, ſome apologize by obſerving that it might have been ſo formerly, and may be ſo ſtill, but for aſtronomical purpoſes, aſtronomical rules muſt be followed. Some boldly attack and refute this doctrine, others explain that by Raku and Cetu, the head and tail of the monſter, is meant the poſition of the moon's nodes and the quantity of its latitude, declaring at the ſame time, that their actual exiſtence and preſence in eclipſes ought to be, and may be believed as an article of faith without prejudice to aſtronomy.

The earth is conſidered as ſpherical, its diameter being divided into 1600 equal parts or Yójanas. For the circumference of a circle, they formerly multiplied the diameter by three, but it is now done by the ſquare root of ten. By the firſt method the diameter is to the circumference as 1 to 3,1627, &c. by the laſt as 1 to 3,14136, &c. by the European method as 1 to 3,14159, &c. In the Puránas the circumference of the earth is made 500000000 Yojans: to account for this, the commentator obſerves that the Yojan in the Súrya Siddhánta contained 100000 of thoſe in the Puránas, or perhaps the earth was equally of that ſize in a former Calpa, or according to others the earth increaſes in bulk from the equator ſouthward, however, for aſtronomical purpoſes the dimenſions given by Surya muſt be aſſumed. A great circle on the earth being thus found, the parallel circles are found as by the European method.

Among various methods to find the latitude of a place, one is by the ſhadow from a perpendicular gnomon when the ſun is in the equator. The gnomon is twelve angulas or digits in length, divided each into ſixty vingulas. The ſhadow at Benares is 5 angulas 45 vingulas. ∴ $\sqrt{12^2 + \overline{5..45}^2} = \overset{A\ \ V.}{13..18}$ = the hypothenuſe of a right angled triangle; which being made radius, the projected ſhadow becomes the ſine of the zenith diſtance, or of the latitude of the place, $= \frac{3438 \times 5..45}{13..18} = 1487'$ whoſe arc is 25°..26′.

The longitude is found by obſervation of lunar eclipſes, calculated for the firſt meridian, which paſſes according to the Súrya Siddánta over Lanca, Róhítaca, Avanti, and Sannihita-ſaras. Avanti is now called Ougein in the Mahratta dominions. The diſtance of Benares from this meridian is ſaid to be ſixty-four Yojan eaſtward ∴ 4565*y*. (a circle of longitude at Benares) : 64*y*. : : 60 (dandas the natural day : 50 Palas, the difference of longitude in time. A total lunar eclipſe was obſerved at Benares fifty-one Palas later than by calculation at Lanca, and $\frac{51 \times 4565{,}4}{60}$ = ſixty-four Yojana, the difference of longitude.

Agreeably to the ſituation of Ougein in Rennel's map, and the longitude of Benares, the equinoctial point Lanca falls in the eaſtern ocean ſouthward from Ceylon and the Maldiva iſlands. Lanca is one of the four cities built by Devatas, at equal diſtances from each other and the poles, whoſe walls are of gold. Meya, whoſe devotions were rewarded with aſtronomical revelations, is ſaid, by the commentator on the Súrya Siddhánta, to have performed them in Sálmala, a country a little to the eaſtward of Lanca. The dominions of Lanca are equal to a twelve part of the equatorial circumference. Hence, perhaps, by Sálmala is meant Ceylon.

To find the moon's cacſha or orbit, the rule is, compute the time of the moon's paſſage from the rational to the ſenſible horizon, or the time of her paſſage over a ſpace equal to the earth's ſemidiameter = 800 Yojan; then as that time is to a periodic month : : 800 Yojan : the circumference of her orbit = 324000 Yojan. The Hindus make no allowance for refraction, nor the moon's motion in a curve. They make the horizontal parallax 53′..20″, and her diſtance from the earth's center 51570 Yojan = 220184 geographical miles. Europeans compute the mean diſtance about 240000 miles.

The planets being ſuppoſed to move in their reſpective orbits at the ſame rate, the dimenſions of the moon's orbit being given, the reſt are alſo eaſily determined. As the planet's revolutions in a Maha Yug are to the moon's revolutions in the ſame cycle, ſo is her orbit to the orbit of the planet.

To find the diameters of the ſun and moon, obſerve the time elapſed between the appulſes of the upper and lower limb to the horizon in three ſigns of anomaly, then as that time is to a natural day, ſo are their orbits to their diameter. The ſun's diameter is 6500 Yojan, the moon's 480. Theſe dimenſions vary in approaching the apoides, in proportion as the apparent motion exceeds or falls ſhort of the mean.

The diameter of the earth's ſhadow at the moon is thus found; let $lm = gb = cd$ (in Plate IX. Fig. 3.) = the earth's diameter. A B = diſtance of the moon from the earth, C D = moon's diameter. A E = ſun's diſtance from the earth, and fi its diameter, fi being given, no is alſo given. The diameter of the earth's ſhadow = $cd - ca - bd$ and $ca + bd : Ae :: fg + hi : AE$, but according to the Hindus, $AE : Ae$: : ſun's diameter : moon's diameter. ∴ Sun's diameter : moon's diameter : : ſun's diameter — earth's diameter ∴ earth's diameter — diameter of the earth's ſhadow.

The diameters of the moon's diſc, the earth's ſhadow, and the place of the node being thus found for the inſtant of oppoſition or full moon, the remaining part of the operation does not differ from the European mode of calculating a lunar eclipſe. The portion of the diſc eclipſed is found in degrees and minutes of a great circle in the Súrya Siddhánta, it may be eſtimated in digits, but theſe are of various dimenſions in different books.

After theſe calculations, it is neceſſary to find the correſponding hour of the civil day to that of the eclipſe in aſtronomical time, and for this purpoſe the ayanánſa or diſtance of the vernal equinox from the firſt of Meſha, and the ſun's right aſcenſion and declination muſt be known.

In the Súrya Siddhánta there is this account of the preceſſion of the equinoxes.

"The

Fig. 1.

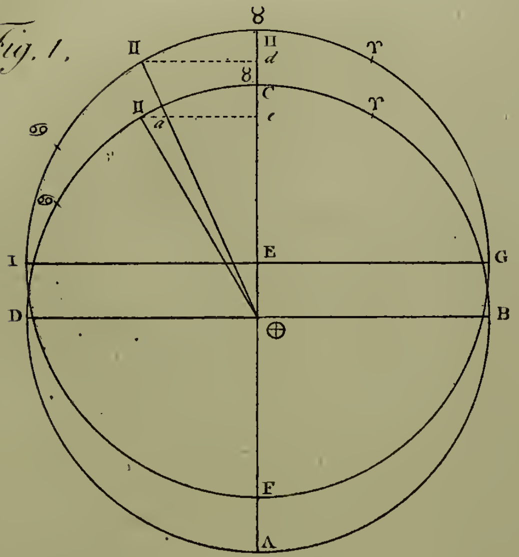


Fig. 2.

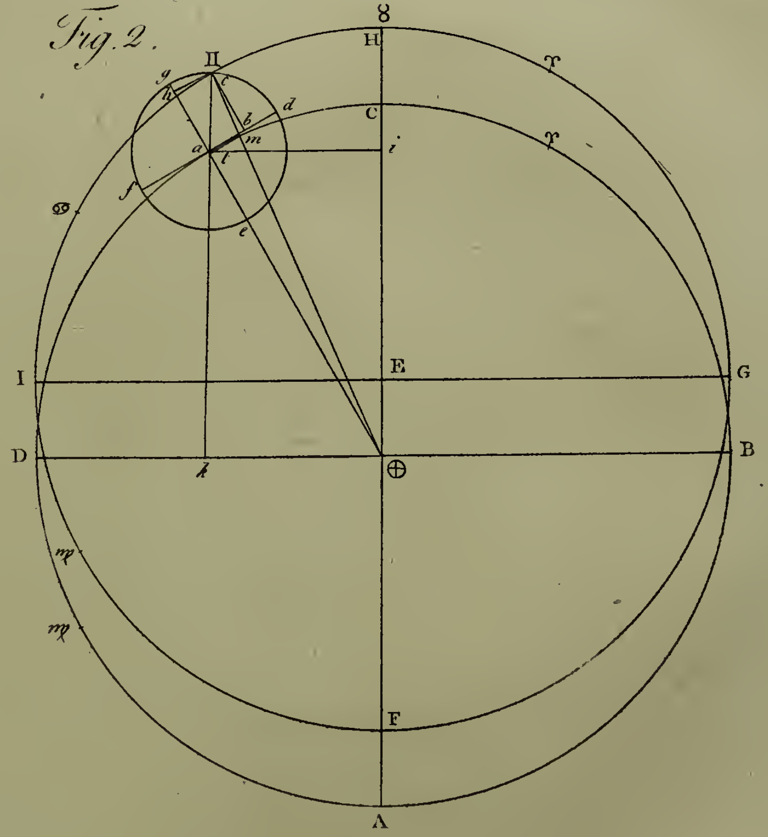


Fig. 3.

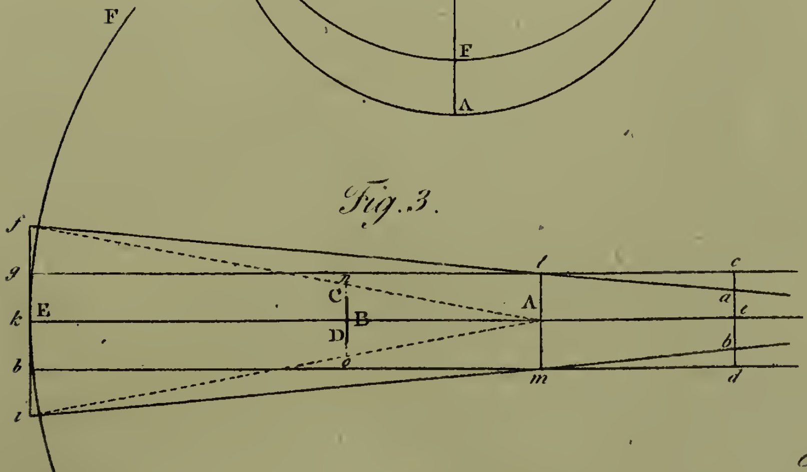
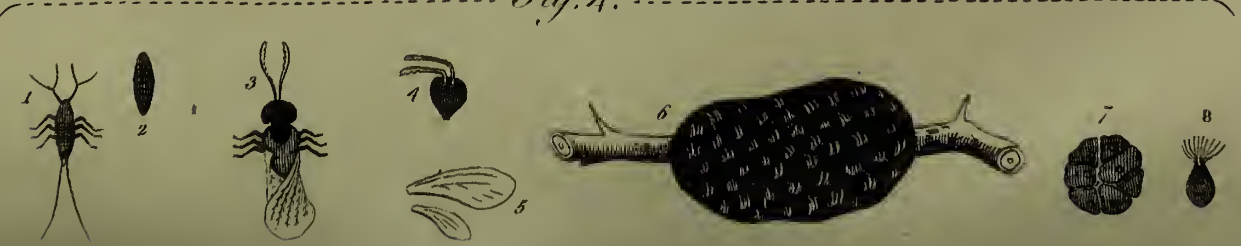


Fig. 4.



"The Ayanánſa moves eaſtward thirty times twenty in each Maha Yug; by that number multiply the Ahargana (number of mean ſolar days for which the calculation is made) and divide the product by the Savan days in a Yug, and of the quotient take the Bhuja, which multiply by three, and divide the product by ten, the quotient is the Ayanánſa.

Commentary. "The Bhaganas (periods) of the Ayanánſa in a Maha Yug are 600, the Saura years in the ſame period 4320000, one period of the Ayanánſa therefore contains 7200 years. Of this period there are four Padas. Firſt Pada, when there was no Ayanánſa, but the Ayanánſa beginning at that time it was added. It continued increaſing 1800 years, when it became at its utmoſt or twenty-ſeven degrees. Second Pada: after this it diminiſhed, but the amount was ſtill added, until at the end of 1800 years more it was diminiſhed to nothing. Third Pada: the Ayanánſa for the next 1800 years was deducted, and the amount deducted at the end of that term was twenty-ſeven degrees. Fourth Pada: the amount deduction diminiſhed, and at the end of the next term of 1800 years, there was nothing either added or ſubtracted. The Munis, having obſerved theſe circumſtances, gave rules accordingly: if in the Savan days of a Maha Yug there are 600 Bhaganas, what will be found in the Ahargana propoſed? Which ſtatement will produce Bhaganas, ſigns, &c.? Reject the Bhaganas, and take the Bhuja of the remainder, which multiply by three, and divide by ten, becauſe there are four Padas in the Bhagana; for if in 90° there is a certain number found as the Bhuja, when the Bhuja degrees are twenty-ſeven, what will be found? and the numbers twenty-ſeven and ninety uſed in the computation, being in the ratio of three to ten, the latter are uſed to ſave trouble."

Hence inſtead of a revolution of the equinoxes through all the ſigns in the courſe of a platonick year, a libration of theſe points is ſuppoſed from the third degree of Piſces, and the twenty-ſeventh of Aries, and from the third of Virgo to the twenty-ſeventh of Libra; as this extraordinary circumſtance is mentioned in ſo old a book as the Súrya Siddhánta, and is the belief of the Hindu aſtronomers, it deſerves the attention of all who are qualified to examine their aſtronomical writings. The Ayanánſa at the beginning of the preſent year was 19°..21′, and conſequently the vernal equinox in Piſces 10°..39′.

The Ayanánſa added to the ſun's longitude in the Hindu ſphere gives the diſtance from the vernal equinox. To find the declination made as radius is to the ſine of the greateſt declination, ſo is the ſine of this diſtance to the ſine of the declination ſought. The declination for one, two, and three ſigns, is determined to be 11°..43′, 20°..38′, and 24°, of which the coſines are 3366′, 3217′, and 3141′. As the coſine of declination for one ſine is to the coſine of greateſt declination, ſo is the ſine of 30° to the ſine of the right aſcenſion of a point at that diſtance from the equinox. Thus the right aſcenſion for the twelve ſigns is found, and by the ſame management of triangles the aſcenſional difference and oblique aſcenſion for any latitude. Theſe particulars are inſerted in the Hindu books as in the following table, calculated for Bhágalpur, on ſuppoſition that the Palabha, or equinoctial ſhadow, is 5 A. 30 V. By the Lagna of Lanca is meant the point of the equator riſing with each thirtieth degree of the ecliptic counted from Aries in a right ſphere, by the Lagna of a particular place the oblique aſcenſion, and by the Chara the aſcenſional difference.

Signs.	Lagna *of* Lancà.		Chara of Bhagalpur.		Ullagna.	
Hindu *Names.*	*In reſpirations anſwering to minutes of the equator.*	*In* palas *or minutes of time* 3600 *to a* Nacſhatra *Day.*	*In reſpirations anſwering to minutes of the equator.*	*In* palas *or minutes of time* 3600 *to a* Nacſhatra *day.*	*In reſpirations anſwering to minutes of the equator.*	*In* palas *or minutes of time* 3600 *to a* Nacſhatra *day.*
Méſha,	1670	278	327	55	1343	224
Vriſha,	1795	299	268	45	1527	255
Mit'huna,	1935	323	110	18	1825	304
Carcata,	1935	323	110	18	2045	341
Sinha,	1795	299	268	45	2063	343
Canyà	1670	278	327	55	1997	333
Tulà,	1670	278	327	55	1997	333
Vriſchica,	1795	299	268	45	2063	343
Dhanus,	1935	323	110	18	2045	341
Macara,	1935	323	110	18	1825	304
Cumbha,	1795	299	268	45	1527	255
Mina,	1670	278	327	55	1343	224
	21600	3600			21600	3600

From the foregoing remarks on the Hindu aſtronomy, it appears evident that every calculation on it muſt be far from accurate. Mr. Davis has calculated an eclipſe on the principles already laid down, and the calculations, which are numerous, are not likely to afford much entertainment to the reader. The reſult differs conſiderably from the nautical almanack. The Siddhánta Rahaſya and Grahalághava, comparatively modern treatiſes, are nearer the truth, yet far from correct. The Hindus, in determining theſe phænomena, are ſatisfied when within a few minutes of the true time.

A comparative ſtatement of this eclipſe as predicted in the Nautical Almanack, with computations of it made by different *Hindu* books. Thoſe marked * are made for different meridians, the laſt I believe for *Tirhút.*

NAMES.	Equated longitude for midnight at *Bhágalpur* ſuppoſed in 8° 50′ E. from *Lancá*, and 88° E. from *Greenwich*.		
	The Sun	*The Moon.*	*The Node.*
	S ° ′ ″	S ° ′ ″	
Súrya Siddhánta,	6 19 54 11	— 17 28 28	1 — 31 44
Tables of Macaranda,	6 19 55 9	— 17 30 9	1 — 32 7
*Grahalághava,			
Siddhánta Rahaſya,	6 19 54 29	— 17 16 25	1 — 27 35

Add to each the *ayanánſa* 19° 21′ 27″ for the longitude counted according to *European* Aſtronomers from the Equinoctial colure.

NAMES.	S ° ′ ″	S ° ′ ″	S ° ′ ″
Súrya Siddhánta,	7 9 15 38	1 6 49 55	1 19 53 11
Tables of Macaranda,	7 9 16 36	1 6 51 36	1 19 53 54
*Grahalághava,			
Siddhánta Rahaſya,	7 9 15 56	1 6 37 52	1 19 49 2
Nautical Almanack,	7 10 47 8	1 7 50 58	1 19 45 30

NAMES.	From midnight to the middle of the Eclipſe.		Duration of the Eclipſe.	
	Hindu time.	*Engliſh time.*	*Hindu time.*	*Engliſh time.*
	D. P. V.	H. M. S.	D. P. V.	H. M. S.
Súrya Siddhánta,	12 53 —	5 9 12	3 12 50	1 17 8
Tables of Macarand			4 50 —	1 46 20
*Grahalághava,	*14 50 —	5 56 —	5 18 —	1 56 36
Siddhánta Rahaſya,	13 53 —	5 33 —	4 58 —	1 49 16
* Grahana Malá, a Catalogue of Eclipſes,	16 6 —	6 26 24	5 26 —	2 10 24
Nautical Almanack,	16 — 37	6 24 15	5 22 2½	2 9 —

XVI. *On the Antiquity of the Indian Zodiack. By the* PRESIDENT.

THE preſident, in oppoſition to Montucla, engages to ſupport, that the Indian diviſion of the zodiack was not borrowed from the Greeks or Arabs, but was probably invented by the firſt progenitors of the Hindu race before their diſperſion. He obſerves, that we muſt not, in charging the Indians with groſs ignorance in regard to the figure of the earth, and the diſtances of the heavenly bodies, confound the ſyſtem of the Jyautiſhicas, or mathematical aſtronomers, with that of the Pauránicas, or poetical fabuliſts. On this ſubject Rámachandra, a venerable mathematician, in his eightieth year made this remark to the preſident. "The Paurànicas" he ſaid, "will tell you that our earth is a plane figure, ſtudded with eight mountains, and ſurrounded by ſeven ſeas of milk, nectar and other fluids; that the part which we inhabit is one of ſeven iſlands, to which eleven ſmaller iſles are ſubordinate; that a god, riding on a huge elephant, guards each of the eight regions, and that a mountain of gold riſes and gleams in the center; but we believe the earth to be ſhaped like a Cadambafruit, or ſpheroidal, and admit only four oceans of ſalt water, all which we name from the four cardinal points, and in which are many great peninſulas, with innumerable iſlands: they will tell you that a dragon's head ſwallows the moon, and thus cauſes an eclipſe, but we know that the ſuppoſed head and tail of the dragon mean only the nodes; in ſhort, they have imagined a ſyſtem which exiſts only in their fancy, but we conſider nothing as true, without ſuch evidence as cannot be queſtioned."

From this and another Brahman he learned, that they divided a great circle into three hundred and ſixty degrees, called Anſas or portions, allotting thirty to each of the twelve ſigns, whoſe names and order correſponding to theſe in our zodiack, are given in the laſt paper.

Stripeti, the author of the Retnamala, deſcribes them thus in Sanſcrit verſes. The ram, bull, crab, lion and ſcorpion, have the figures of thoſe five animals reſpectively, the pair are a damſel playing on a Vínà, and a youth wielding a mace, the virgin ſtands on a boat in water, holding in one hand a lamp, in the other an ear of rice corn, the balance is held by a weigher with a weight in one hand, the bow by an archer whoſe hinder parts are like thoſe of a horſe, the ſea-monſter has the face of an antelope, the ewer is a waterpot borne on the ſhoulder of a man who empties it, the fiſh are two with their heads turned to each others tails, and all theſe are ſuppoſed to be in ſuch places as ſuit their natures.

To each of the twenty-ſeven lunar ſtations or Nacſhatras, they allow thirteen Anſas and one third. Their names are; As'winí. Bharaní. Criticà. Róhiní. Mrigaſiras. A'rdrà. Punarvaſu. Puſhya. As'léſhá. Maghà. Púrva p'halguní. Uttara p'halguní. Haſta. Chitrà. Swátì. Víſác'hà. Annurádhà. Jyéſht'hà. Múla. Púrváſhádha. Uttaráſhádhà. Sravanà. Dhaniſh'tà. Satabhiſhà. Púrva bhadrapadà. Uttarabhadrapadá. Révatì.

Between the twenty-firſt and twenty-ſecond conſtellations, are three ſtars called Abhijit, but they are the laſt quarter of the aſteriſm or Aſhár immediately preceding. The Hindus not having attained to very great exactneſs, fixed on the number 27 as the neareſt to the lunar period, and inſerted Abhijit for ſome aſtrological purpoſes in their nuptial ceremonies.

The figures of the twenty-ſeven conſtellations are deſcribed by the author of the Retnamala:

"A HORSE's head *yóni* or *bhaga*; a razor; a wheeled carriage; the head of an antelope; a gem; a houſe; an arrow; a wheel; another houſe; a bedſtead; another bedſtead; a hand; a pearl; a piece of corral; a feſtoon of leaves; an oblation to the Gods; a rich ear-ring; the tail of a fierce lion; a couch; the tooth of a wanton elephant, near which is the kernel of the *s'rîngátaca* nut; the three footſteps of VISHNU; a tabor; a circular jewel; a two-faced image; another couch; and a ſmaller ſort of tabor: ſuch are the figures of *Aſwiní* and the reſt in the circle of lunar conſtellations.

The *Hindu* draughtſman has very ill repreſented moſt of the figures; and he has tranſpoſed the two *Aſhâras* as well as the two *Bhadrapads*; but his figure of *Abhijit*, which looks like our ace of hearts, has a reſemblance to the kernel of the *trapa*, a curious water-plant deſcribed in a ſeparate eſſay. In another *Sanſcrit* book the figures of the ſame conſtellations are thus varied: A horſe's head. *Yóni* or *bhaga*. A flame. A waggon. A cat's paw. One bright ſtar. A bow. A child's pencil. A dog's tail. A ſtraight tail. Two ſtars S. to N. Two N. to S. A hand. A pearl. Red ſaffron. A feſtoon. A ſnake. A boar's head. A conch. A winnowing fan. Another. An arrow. A tabor. A circle of ſtars. A ſtaff for burdens. The beam of a balance. A fiſh.

The Indian months take their names from twelve of the Nacſhatras, becauſe in former times the aſtronomers ſuppoſe that the moon was at the full in each month on the very day that it entered the Nacſhatra. The Pauránicas feign that the god Soma, or Lunus, having wedded twelve nymphs, who preſided each over a conſtellation, had by them twelve genii, or months, ſo named from their ſeveral mothers. A'ſwina. Cártica. Márgasírſha. Pauſha. Mágha. P'hálguna. Chaitra. Vaiſác'ha. Jyaiſh't'ha. A'ſhára. Srávana. Bhádra.

The manſions are thus denoted in the Paranes Almanack, by the firſt letters of their names.

MONTHS.	SOLAR ASTERISMS.		MANSIONS.	
A'ſwin	Méſh		A + bh + $\frac{c}{4}$	
Cártic	Vriſh		$\frac{3c}{4}$ + rò + $\frac{M}{2}$	
A'graháyan	Mi'thun		$\frac{M}{2}$ + á + $\frac{3P}{4}$	
Pauſh	Carca't	4.	$\frac{P}{4}$ + p + sl.	9.
Mágh	Sinh		m + PU + $\frac{U}{4}$	
P'hálgun	Canyá		$\frac{3U}{4}$ + h + $\frac{ch}{2}$	
Chaitr	Tulá		$\frac{ch}{2}$ + s + $\frac{3v}{4}$	
Vaiſác'h	Vriſchic	8.	$\frac{v}{4}$ + a + J	18.
Jaiſh't'h	Dhan		mú + pù + $\frac{u}{4}$	
A'ſhár	Macar		$\frac{3u}{4}$ + S + $\frac{dh}{2}$	
Srávan	Cumbh		$\frac{dh}{2}$ + 's + $\frac{3\,\textit{pú}}{4}$	
Bhádr	Min	12.	$\frac{\textit{pú}}{4}$ + *u* + r.	27.

Hence we may readily know the ſtars in each manſion, as they follow in order:

LUNAR MANSIONS.	SOLAR ASTERISMS.	STARS.
Aſwiní.	Ram.	*Three* in and near the head.
Bharaní.	———	*Three* in the tail.
Criticà.	Bull.	*Six* of the Pleíads.
Róhiní.	———	*Five* in the head and neck.
Mrigaſiras.	Pair.	*Three* in or near the feet, perhaps in the Galaxy.
A'rdrà.	———	*One* on the knee.
Punarvaſu.	———	*Four* in the heads, breaſt and ſhoulder.
Puſhya.	Crab.	*Three* in the body and claws.
Aſléſhà.	Lion.	*Five* in the face and mane.
Maghà.	———	*Five* in the leg and haunch.
Púrvap'halgunì.	———	*Two*, one in the tail.
Uttarap'halgunì.	Virgin.	*Two* on the arm and zone.
Haſta.	———	*Five* near the hand.
Chitrà.	———	*One* in the ſpike.
Swáti.	Balance.	*One* in the N. Scale.
Vis'ác'hà.	———	*Four* beyond it.
Anurádhà.	Scorpion.	*Four* in the body.
Jyéſht'hà.	———	*Three* in the tail.
Múla.	Bow.	*Eleven* to the point of the arrow.
Púrváſhára.	———	*Two* in the leg.
Uttaráſhára.	Sea-monſter.	*Two* in the horn.
Sravanà.	———	*Three* in the tail.
Dhaniſht'à.	Ewer.	*Four* in the arm.
Satabhiſhà.	———	*Many* in the ſtream.
Púrvabhadrapadà.	Fiſh.	*Two* in the firſt fiſh.
Uttaraphadrapadà.	———	*Two* in the cord.
Révatì.	———	*Thirty-two* in the ſecond fiſh and cord.

$A + bh + \frac{c}{4}$ means manſions Aſwiní, Bharanî, and a fourth of Criticà, and ſo of the reſt.

The twenty-ſeven Yoga ſtars have particular names in the order of the Nacſhatras, as here ſubjoined. Viſhcambha. Príti. A'yuſhmat. Saubhágya. Sóbhana. Atiganda. Sucarman. Dhriti. Súla. Ganda. Vriddhi. Dhruva. Vyághàta. Herſhana. Vajra. Aſrij. Vyatipáta. Varíyas. Parigha. Siva. Siddha. Sádhya. Subha. Sucra. Brahman. Indra. Vaidhriti.

The antiquity of this zodiacal diviſion may be preſumed from the contempt in which the Brahmans hold all thoſe nations, who are ignorant of their Védas. They have a proverb, no baſe creature can be lower than a Yavan, by which was formerly meant an Ionian or Greek, but now a Mogul or a Muſelman. The Pandits laughed heartily at Montucla's notion, and could not be perſuaded to give it ſerious attention. The reſemblance of the Indian to the Greek ſigns is no more a proof of the originality of the latter, than that the Indians borrowed their days of the week from the Goths, becauſe they are dedicated to the ſame deities. Rais the ſun, Soma the moon, Mangala Tuiſco, Budha Woden, Vrihaſpati Thor, Sucra Freya, Sani Sater.

The names and forms of the lunar conſtellations indicate a ſimplicity of manners peculiar to an ancient people, and differ entirely from thoſe of the Arabian ſyſtem. The Menazilu'l Kamar, or lunar ſtages of the Arabs, have twenty-eight names in the following order, the particle al being underſtood before every word.

Sharatàn. Bútain. Thurayyà. Debaràn. Hakâah. Hanâah. Dhirââ. Nathrah. Tarf. Jabhah. Zubrah. Sarſah. Awwà. Simàc. Gaſr. Zubáníyah. Iclìl. Kalb. Shaulah. Naâïm. Beldah. Dhábih'. Bulaâ. Suûd. Akhbíya. Mukdim, Múkhir. Riſhâ.

The number of ſtars in theſe menzils ſeldom agree with thoſe of the Indians, and there is no evidence of any communication between the Hindus and Arabs on any ſubject of literature or ſcience. For though a commercial intercourſe might have ſubſiſted in very early times, it is not probable that the Brahmans, who alone were permitted to read the ſix Vedangas, one of which is the aſtronomical Saſtra, either could or would have converſed with Arabian merchants.

The great antiquity of Menús inſtitutes, in which the twenty-ſeven aſteriſms are called daughters of Dacſha and conſorts of Soma the moon, and the occurrence of the names in the Vedas, carry their origin back to a very late date, for both from internal and external evidence one of the Vedas appears to be more than three thouſand years old. The preſident hopes on ſome other occaſion to ſatisfy the public, that the practice of obſerving the ſtars began with the rudiments of civil ſociety in the country of the Chaldeans, was from thence propagated into Egypt, India, Greece, Italy and Scandinavia, before the reign of Siſac or Sácya, a thouſand years before Chriſt, and that Chiron and Atlas, ſuppoſed to be the inventors of ſpheres in Greece and Lybia, were allegorical perſonages, which ought to have no place in the ſerious hiſtory of our ſpecies.

XVII. *An Account of the Kingdom of Népál. By Father* GIUSEPPE, *Prefect of the Roman Miſſion.*

THIS kingdom is ſituated N.E. of Patna, diſtant about ten or eleven days journey. The road lays through the kingdom of Macwanpur. Near Népál the road is good, but bad in the mountains, narrow and dangerous. At the foot of the hills the air is unwholeſome, from March to November, and putrid fevers are common and fatal. On the interior mountains you have a fine view of the plains of Népál, reſembling an amphitheatre, covered with towns and villages: this plain is about 200 miles circumference, and ſurrounded on all ſides with hills.

There are three principal cities in the plain, each of which was the capital of a large kingdom; the chief of which is called Cat'hmándá, and contains about 18,000 houſes: this kingdom extends to Thibet; the king has 50,000 ſoldiers in his ſervice. The ſecond, ſituated S. W. of Cat'hmándá, is called *Lelit Patan,* contains 24,000 houſes: this kingdom borders on *Macwanpur.* The third city is called B'hátgán, contains 12,000 families; the kingdom extends eaſt, and borders on a nation called *Ceratas,* who profeſs no religion. Thoſe and the ſmaller towns are well built, the houſes of brick, three or four ſtories high, and have doors and windows of wood. The ſtreets are paved, and in moſt of them wells, made of ſtone, for public uſe. In every town are ſquare verandas, called *Pali,* and many of them with wells. Without the towns are ſquare reſervoirs of water to bathe in.

The religion of *Népál* is of two kinds; one ſect, the moſt ancient, is profeſſed by many, who call themſelves *Baryeſu,* pluck their hair from their heads, dreſs in coarſe red woollen, are conſidered as a religious order, have monaſteries, and in them each perſon has a ſeparate apartment; they have particular feſtivals, in one of which, at *Lelit Patan,* they draw an idol, called *Baghere,*[*] in a ſtately car. The other religion is that of the *Brahmans,* as followed in Hinduſtan in its purity. Their places of worſhip are very numerous and magnificent. In Lelit Patan, the temple was more valuable than the houſe of the king. The ſmall temples have ſtairs, by which one perſon may aſcend on the outſide; ſome have four ſides, others ſix, with marble pillars poliſhed ſmooth, with two or three pyramidal ſtones; the ornaments are gilt and neat. The larger temples have ſtone pillars round them, twenty to thirty feet high, on which they place their idols. There are many ſmall bells in the cupolas.

Eaſtward of Cat'hmándá, about three miles, is a place called Tolu, by which runs a river, the water of which is eſteemed holy, and to which they carry perſons of high rank at the point of death. They have an idea, that in two or three places treaſures are buried under ground, which have belonged to ſome temples; the king, while Mr. Shore was in Népál, opened one of theſe places to pay the expences of a war.

Weſtward of *Lelit Patan,* is a caſtle, called Banga, where is a temple, which Mr. Shore viſited, the magnificence of which, he thinks, is not to be equalled in Europe. There are alſo in their towns many curioſities.

The kingdom of Népál is, he thinks, very ancient, but was ruined by the diſſentions among the three kings.

XVIII. *On the Cure of Perſons bitten by Snakes.* By John Williams, *Eſq.*

THIS is merely a ſtatement of facts relative to the cure of perſons bitten by ſnakes, by means of the volatile alkali, given either in the form of *eau de luce,* or in that of the cauſtic alkaline ſpirit. Mr. Williams previouſly obſerves, that "from the effect of a legature applied between the part bitten and the heart, it is evident that the poiſon diffuſes itſelf over the body by the returning venous blood; deſtroying irritability, and rendering the ſyſtem paralytic. It is therefore probable that the volatile cauſtic alkali does not act ſo much as a ſpecific in deſtroying its quality, as by counteracting its effect on the ſyſtem by ſtimulating." The caſes, in number ſeven, are ſelected out of many. In *four,* the ſpecies of ſnake cauſing the injury was aſcertained to be the *Cobra de Capello,* and it was probably ſo in *two* more. The conſtant ſymptoms of this poiſon are convulſions about the throat and fauces, occaſioning difficulty in ſwallowing; but when the patient has been able to ſwallow, Mr. Williams has never known the volatile alkali fail in its effect. Doſes of thirty to ſixty drops in water, were repeated every five or ten minutes till the dangerous ſymptoms were over, together with external application of the ſame to the wound. The recovery was generally very ſpeedy. Mr. Williams cautions againſt the previous adminiſtration of oil, as it impedes the efficacy of the alkaline ſpirit." The laſt caſe relates to the bite of a ſnake called by the natives *Krait*, a ſpecies of *Boa*. In this inſtance the alkali once exhibited ſeemed to have removed the dangerous ſymptoms, and the patient was taken away without repetition of the doſe, but died ſhortly after.

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[*] Mr. Shore ſuppoſes they mean *Bhagavat,* or *Criſhna.*

XIX. *On the Roman Coins found at Nelòr.* *By* ALEXANDER DAVIDSON, *Eſq.*

A Peaſant near Nelòr, about 100 miles weſt of Madras, ploughing on the ſide of a hill, diſcovered the remains of a Hindu temple, under which was a little pot with Roman coins and medals of the ſecond century. They were ſold as old gold, and ſome melted, but about thirty of them ſaved, two of which Mr. Davidſon choſe, an *Adrian* and a *Fauſtina*. Some of *Trajan's* were in good preſervation. Many of them were freſh and beautiful, as if juſt come from the mint, and all of pure gold.

XX. *On two Hindu Feſtivals, and the Indian Sphinx.* *By the late Col.* PEARCE.

I. ON the feſtival of *Bavání*, celebrated by the *Hindus* who keep horned cattle, they viſit gardens, erect a pole, and adorn it with garlands; this happens on the firſt of May, on which day the ſame rites are performed by the ſame claſs of people in England, which is known to be a relict of ancient ſuperſtition. The Hindu feaſt does not always anſwer to the firſt of that month. Col. Pearſe obſerves, that there ſeems in this to be an affinity between the religion of the eaſt and the old religion of Britain.

II. There is another cuſtom during the Huli, when mirth and feſtivity reign among the Hindus of every claſs; they divert themſelves with ſending people on errands that are to end in diſappointment, and raiſe a laugh at their expence. The Huli is in March, and the laſt day is the greateſt holiday; all the *Hindus* on that day, at *Juggannat'h*, are entitled to certain diſtinctions, which they hold of great importance. In the diverſion the higheſt claſſes join.

III. At Jaggannat'h Col. Pearſe ſaw the ſyhinx of the Egyptians, which he was told by a *Pandit*, that it is to appear at the end of the world, and prey on an elephant; he is therefore figured ſeizing an elephant in his claws. When the Colonel told his informant that the Egyptians worſhipped a bull with a black mark on his tongue, and adored birds and trees, he exclaimed, "Then their religion is like ours, for we chuſe our *ſacred bulls* by the *ſame marks*; we reverence ſome birds, as the *hanſa*, *gagarura*, &c. and reſpect certain trees, as the *peppal*, *vata*, &c."

On this the preſident remarks, that he had been aſſured the figure above-mentioned was only the repreſentation ſeizing an elephant.

XXI. *A ſhort Deſcription of Carnicobar.* *By* M. G. HAMILTON.

CARNICOBAR is the northernmoſt of the Nicobar iſlands, in the Bay of Bengal, it is low, round, and about forty miles in circumference. It produces moſt of the tropical fruits, yams, and a root called *cachu*. There is an animal of the lizard kind, but large, called a *tolonqui*, which carries off fowls and chickens. There are abundance of ſnakes, and the inhabitants frequently die of their bites. Timber is plenty and good.

The natives are of low ſtature, but active and ſtrong; are copper-coloured, and their features have a caſt of the *Malay*; the women are very ugly. The men cut their hair ſhort, the women ſhave their heads, and wear only a ſhort petticoat of graſs, not wove, but hanging like the thatch of a houſe; the men wear a narrow ſlip of cloth round the middle. The ears of both ſexes are pierced when young, and they contrive to render the holes wide. They are good-humoured, and fond of eating with Europeans; they eat enormouſly, and are fond of arrack. They paſs their time in dancing and feaſting, and are very fond of pork. The hogs and other animals are fed on cocoa-nuts. They have plenty of ſea fiſh, which they ſtrike with lances, and are ſure of killing at ten or twelve yards diſtance. They eat their victuals almoſt raw; their drink is cocoa-nut milk, and a liquor called *ſoura*, from the young ſprouts of the cocoa-tree, which they ſuffer to ferment before it is uſed. After eating, the young perſons dreſs themſelves with leaves, and dance; the old ones ſmoke tobacco, and drink *ſoura*. The dancers ſing, their only muſical inſtruments is a bamboo, 2½ feet long, and 3 inches diameter, with one ſtring ſtretched on it, and played on as a guittar.

What they know of phyſic is ſmall. Their houſes are built on the beach in villages; each houſe contains about twenty perſons; they are raiſed on pillars ten feet from the ground, are round like bee-hives, and the entrance is by a trap-door: this method of building is to ſecure them from ſnakes and rats; the flooring is of bamboo, and the inſide neatly finiſhed. They have no cloth but what they exchange with the ſhips that come there for cocoa-nuts; they have no coin, and what is brought by foreigners, they eſteem only as ornaments; however, they are good judges of gold and ſilver.

They purchaſe more cloth than they uſe; the ſurplus they ſend to a ſmall iſland, ſouth of theirs, called *Choury*, to which they ſend a fleet of boats every year, and purchaſe canoes with it, for they do not make any. They have no ceremonies, and hate diſhoneſty. When they travel, they enter any houſe, take what they want, reſt themſelves, and ſet off without taking notice of any of the family. Theft is ſo rare among them, that they never ſhut their doors. They have much intercourſe with ſtrangers, and have acquired a little bad Portugueſe; their own language is different from moſt others, having a ſtop or catch at every ſyllable.

They have no notion of a God, but believe and worſhip a devil. They have a pole erected in every village, which they ſay has the virtue to keep him at a diſtance. When a man dies, his live ſtock and moveables are buried with him, he is mourned by the whole village, and his wife muſt have a joint cut off from one of her fingers. They wrap up the corpſe in leaves and cloth, and bury it; a pole, as a kind of monument, is erected over the grave. Polygamy is unknown, and adultery puniſhed. There ſeems among them a perfect equality, except a little reſpect paid to age, but no appearance of authority one over another.

The inhabitants of the *Andemans* are ſaid to be cannibals, and the *Nicobarians* the moſt harmleſs people alive. Mr. Hamilton ſays, it is remarkable that there ſhould be ſuch a wide difference between two people, inhabitants of iſlands ſo near each other. But it is accounted for by the following anecdote, which he was aſſured is true.

Soon after the Portugueſe paſſed round the Cape of Good Hope, a ſhip of that nation, with a number of Moſambique negroes on board, was loſt on the Andeman iſlands, which were before uninhabited. The Europeans built a ſmall ſhallop, and ſailed for Pegu; the blacks remained in the iſland, and ſettled it. On the other hand, the Nicobar iſlands were peopled from the oppoſite main and coaſt of Pegu. It is ſaid the languages of Pegu and Nicobar have great reſemblance.

XXII. *The Deſign of a Treatiſe on the Plants of India. By the* PRESIDENT.

IN compiling a treatiſe on Indian plants, the firſt ſtep, in the writer's opinion, ſhould be to write the names given them in the vocabularies and medical tracts of that country, in Roman letters, according to the moſt accurate orthography, and in Sanſcrit preferably to any vulgar dialect. This leads him to a cenſure of "the childiſh denominations of plants from the perſons who firſt deſcribed them; for," ſays he, "*Chamfaca* and *Hinna* ſeem to me not only more elegant, but far properer, deſignations of an Indian and an Arabian plant, than *Michelia* and *Lawſonia*." With reſpect to the Linnean ſyſtem, he thinks that in its general principles it will ever be found the cleareſt and moſt convenient of methods of arrangement, and therefore ſhould be ſtudiouſly obſerved in the deſigned work. But he propoſes to reject the Linnean appellations of the twenty-four claſſes, as formed contrary to analogy of language, and ſeveral of them faulty in diſcrimination; and in their ſtead would uſe numerals for the firſt eleven claſſes, and ſhort phraſes for the reſt. The allegory of *ſexes* and *nuptials*, even if it were complete, ought, he thinks, to be diſcarded, as unbecoming the gravity of a ſcientific purſuit, and tending to render the ſtudy of botany unfit for women, to whom it is in many reſpects ſo ſuitable. After the Sanſcrit names of the plants have been correctly written, and the plants themſelves claſſed and deſcribed, their ſeveral uſes in medicine, diet, and manufactures ſhould be collected from the medical books in Sanſcrit, with the aſſiſtance of the Hindu phyſicians, and their accounts either eſtabliſhed or diſproved by experiments.

By way of example, the preſident annexes the deſcriptions of five Indian plants. Theſe we ſhall copy.

I. MUCHUCUNDA.

Twenty, from One Baſe.

Cal. Five-parted, thick; leaflets, oblong.

Cor. Five petals, oblong.

Stam. From twelve to fifteen, rather long, fertile; five ſhorter, ſterile. In ſome flowers, the *unprolifick* ſtamens, longer.

Piſt. *Style* cylindrick.

Peric. A capſule, with five cells, many-ſeeded.

Seeds: Roundiſh, compreſſed, winged.

Leaves: Of many different ſhapes.

Uſes: The quality, refrigerant.

One flower, ſteeped a whole night in a glaſs of water, forms a cooling mucilage of uſe in virulent gonorrhœas. The *Muchucunda*, called alſo *Pichuca*, is exquiſitely fragrant; its calyx is covered with an odoriferous duſt; and the dried flowers in fine powder, taken like ſnuff, are ſaid, in a *Sanſcrit* book, almoſt inſtantaneouſly to remove a nervous head-ach.

Note. This plant differs a little from the *Pantapetes* of LINNÆUS.

II. BILVA OR MA'LU'RA.

Many on the Receptacle, and One.

Cal. Four, or five-cleft, beneath.

Cor. Four, or five, petals; moſtly reflex.

Stam. Forty, to forty-eight, filaments; anthers, moſtly erect.

Piſt. *Germ*, roundiſh; *Style*, ſmooth, ſhort; *Stigma*, clubbed.

Peric. A ſpheroidal berry, very large; many-ſeeded.

Seeds: Toward the ſurface, ovate, in a pellucid mucus.

Leaves: Ternate; common petiole, long; leaflets, ſubovate; obtuſely notched, with ſhort petioles; ſome almoſt lanced.

Stem: Armed with ſharp thorns.

Uſes: The fruit nutritious, warm, cathartick; in taſte, delicious; in fragrance, exquiſite: its aperient and deterſive quality, and its efficacy in removing habitual coſtiveneſs, have been proved by conſtant experience. The mucus of the ſeed is, for ſome purpoſes, a very good cement.

Note. This fruit is called *Srîp'hala*, becauſe it ſprang, ſay the *Indian* poets, from the milk of *Srì*, the goddeſs of abundance, who beſtowed it on mankind at the requeſt of ISWARA, whence he alone wears a chaplet of *Bilva* flowers; to him only the *Hindus* offer them; and, when they ſee any of them falling on the ground, they take them up with reverence, and carry them to his temple. From the firſt bloſſom of this plant, that I could inſpect, I had imagined, that it belonged to the ſame claſs with the *Durio*, becauſe the filaments appeared to be diſtributed in five ſets; but in all, that I have ſince examined, they are perfectly diſtinct.

III. SRINGATA'CA.

Four and One.

Cal. Four-cleft, with a long peduncle, above.

Cor. Four petals.

Stam. Anthers, kidney-ſhaped.

Piſt. *Germ*, roundiſh; *Style*, long as the filaments; *Stigma*, clubbed.

Seeds: A *Nut* with four oppoſite angles (two of them *ſharp* thorns) formed by the *Calyx*.

Leaves: Thoſe, which float on the water, are rhomboidal; the two upper ſides unequally notched, the two lower, right lines. Their petioles, buoyed up by ſpindle-ſhaped ſpongy ſubſtances, not bladders.

Root: Knotty, like coral.

Uſes: The freſh kernel, in ſweetneſs and delicacy, equals that of the filberd. A mucus, ſecreted by minute glands, covers the wet leaves, which is conſidered as cooling.

Note. It ſeems to be the floating *Trapa* of LINNÆUS.

IV. PU'TI CARAJA.

Ten and One.

Cal. Five-cleft.

Cor. Five equal petals.

Peric. A thorny legumen; two ſeeds.

Leaves: Oval, pinnated.

Stem: Armed.

Uſes: The ſeeds are very bitter, and, perhaps, tonick; ſince one of them, bruiſed and given in two doſes, will, as the *Hindus* aſſert, cure an intermittent fever.

V. MADHU'CA.

Many, *not* on the Receptacle, and One.

Cal. *Perianth* four, or five-leaved.

Cor. One-petaled. *Tube* inflated, fleſhy. *Border* nine, or ten-parted.

Stam. *Anthers* from twelve to twenty-eight, erect, ſubvillous.

Piſt. *Germ*, roundiſh; *Style*, long, awl-ſhaped.

Peric. A *Drupe*, with two or three *Nuts*.

Leaves: Oval, ſomewhat pointed.

Uſes: The *tubes*, eſculent, nutritious; yielding, by diſtillation, an inebriating ſpirit, which, if the ſale of it were duly reſtrained by law, might be applied to good purpoſes. A uſeful oil is expreſſed from the ſeed.

Note. It reſembles the *Baſſia* of KOENIG.

XXIII. *On the Diſſection of the Pangolin, in a Letter to General* CARNAC *from* ADAM BURT, *Eſq.*

THIS animal is the ſame ſpecies with that deſcribed in the firſt volume of this work. It is an inoffenſive creature, without teeth, and though its feet are furniſhed with five claws, they are unable to graſp. Nature ſeems therefore to have truſted its defence merely to its coat and mail, and its power of digging in the ground and concealing itſelf.

" The upper jaw is covered with a croſs cartilaginous ridge, which, though apparently not at all ſuited to any purpoſes of maſtication, may, by encreaſing the ſurface of the palate, extend the ſenſe of taſte.

" The œſophagus admitted my forefinger with eaſe. The tongue at the bottom of the mouth is nearly about the ſize of the little finger, from whence it tapers to a point. The animal at pleaſure protrudes this member a great way from the mouth. The tongue ariſes from the enſiform cartilage, and the contiguous muſcles of the belly, and paſſes in form of a round diſtinct muſcle from over the ſtomach, through the thorax, immediately under the ſternum; and interior to the windpipe in the throat. When diſſected out, the tongue could be eaſily elongated ſo as to reach more than the length of the animal excluſive of its tail. There is a cluſter of ſalivary glands ſeated around the tongue, as it enters the mouth. Theſe will neceſſarily be compreſſed

preſſed by the action of the tongue, ſo as occaſionally to ſupply a plentiful flow of their ſecretion.

"The ſtomach is *cartilaginous*, and analogous to that of the gallinaceous tribe of birds. It was filled with ſmall ſtones and gravel, which in this part of the country, are almoſt univerſally calcareous. The inner ſurface of the ſtomach was rough to the feel, and formed into folds, the interſtices of which were filled with a frothy ſecretion. The guts were filled with a ſandy pulp, in which, however, were interſperſed a few diſtinct ſmall ſtones. No veſtiges of any animal or vegetable food could be traced in the whole primæ viæ. The gall-bladder was diſtended with a fluid, reſembling in colour and conſiſtence the dregs of beer.

"The ſubject was a female: its dugs were two, ſeated on the breaſt. The uterus and organs of generation were evidently thoſe of a viviparous animal."

From the appearances in the inteſtinal canal of this animal, the writer was forcibly led to conjecture that it might poſſibly derive its nouriſhment from *mineral ſubſtances.* That minerals are capable of yielding nutriment to animal bodies, he thinks rendered probable by various conſiderations. Dr. Prieſtley's query, "May not phlogiſtic matter be the moſt eſſential part of the food and ſupport of both vegetable and animal bodies?" he is inclined to anſwer in the affirmative; and of this, earth, he ſuppoſes, would yield a ſupply; as it would alſo of the calcareous matter of bones, ſcales, &c. Some birds, as appears from the experiments of *M. Bruquatelli* of *Pavia*, have ſo great a ſolvent power in their gaſtric juice, as to diſſolve in their ſtomachs flints, rock cryſtal, calcareous ſtones and ſhells. And he conceives that every thing which is ſoluble in the ſtomachs of animals may be abſorbed into their circulating ſyſtem. He concludes with obſerving, that *M. de Buffon* muſt probably have been miſled by the ſhrivelled ſtate of a dried preparation of this animal, or he would not have aſſerted that all quadrupeds covered with ſcales are oviparous.

XXIV. *On the Lácſhà, or Lac Inſect.* By *Mr.* W. ROXBURGH, *Surgeon and Botaniſt to the Eaſt India Company. Communicated January* 2, 1790.

"SOME pieces of very freſh-looking lac, adhering to ſmall branches of *mimoſa cinerea*, were brought me from the mountains on the 20th of laſt month. (Plate IX. Fig. 4.) I kept them carefully, and to-day, the 4th of *December*, 14 days from the time they came from the hills, myriads of exceedingly minute animals were obſerved creeping about the lac, and branches it adhered to, and more ſtill iſſuing from ſmall holes over the ſurface of the cells: other ſmall and perforated excreſcences were obſerved with a glaſs amongſt the perforations, from which the minute inſects iſſued, regularly two to each hole, and crowned with ſome very fine white hairs. When the hairs were rubbed off, two white ſpots appeared. The animals, when ſingle, ran about pretty briſkly, but in general they were ſo numerous as to be crowded over one another. The body is oblong, tapering moſt towards the tail, below plain, above convex, with a double or flat margin: laterally on the back part of the thorax are two ſmall tubercles which may be the eyes: the body behind the thorax is croſſed with twelve rings: legs ſix: feelers (antennæ) half the length of the body, jointed, hairy, each ending in two hairs as long as the antennæ: rump, a white point between two terminal hairs, which are as long as the body of the animal. The mouth I could not ſee. On opening the cells, the ſubſtance that they were formed of cannot be better deſcribed, with reſpect to appearance, than by ſaying it is like the tranſparent amber, that beads are made of: the external covering of the cells may be about half a line thick, is remarkably ſtrong and able to reſiſt injuries; the partitions are much thinner: the cells are in general irregular ſquares, pentagons and hexagons, about an eighth of an inch in diameter, and $\frac{1}{4}$ deep: they have no communication with each other: all thoſe I opened, during the time the animals were iſſuing, contained in one half, a ſmall bag filled with a thick red jelly-like liquor replete with what I take to be eggs; theſe bags, or utriculi, adhere to the bottom of the cells, and have each two necks, which paſs through perforations in the external coat of the cells forming the fore-mentioned excreſcences, and ending in ſome very fine hairs. The other half of the cells have a diſtinct opening, and contain a white ſubſtance, like ſome few filaments of cotton rolled together, and numbers of the inſects themſelves ready to make their exit; ſeveral of the ſame inſects I obſerved to have drawn up their legs and to lie flat: they did not move on being touched, nor did they ſhow any ſigns of life with the greateſt irritation.

" *December* 5. The ſame minute hexapedes continue iſſuing from their cells in numbers; they are more lively, of a deepened red colour, and fewer of the motionleſs ſort. To-day I ſaw the mouth: it is a flattened point about the middle of the breaſt, which the little animal projects on being compreſſed.

" *December* 6. The male inſects I have found to-day: a few of them are conſtantly running among the females moſt actively: as yet they are ſcarce more, I imagine, than one to 5000 females, but twice their ſize. The head is obtuſe; eyes black, very large; antennæ clavated, feathered, about two-thirds the length of the body: below the middle an articulation, ſuch as thoſe in the legs: colour between the eyes a beautiful ſhining green: neck very ſhort: body oval, brown: abdomen oblong, the length of body and head: legs ſix: wings membranaceous, four, longer than the body, fixed to the ſides of the thorax, narrow at their inſertions, growing broader for two-thirds of their length, then rounded: the anterior pair is twice the ſize of the poſterior: a ſtrong fibre runs along their anterior margins: they lie flat like the wings of a common flie, when it walks or reſts: no hairs from the rump: it ſprings moſt actively to a conſiderable diſtance on being touched: mouth in the under part of the head: maxillæ tranſverſe. To-day the female inſects continue iſſuing in great numbers, and move about as on the 4th.

" *December* 7. The ſmall red inſects ſtill more numerous, and move about as before: winged inſects, ſtill very few, continue active. There have been freſh leaves and bits of the branches of both mimoſa cinerea and corinda put into the wide-mouthed bottle with them: they walk over them indifferently without ſhowing any preference nor inclination to work nor copulate. I opened a cell whence I thought the winged flies had come, and found ſeveral, eight or ten, more in it, ſtruggling to ſhake off their incumbrances: they were in one of thoſe utriculi mentioned on the 4th, which ends in two mouths, ſhut up with fine white hairs, but one of them was open for the exit of the flies; the other would no doubt have opened in due time: this utriculus I found now perfectly dry, and divided into cells by exceeding thin partitions. I imagine, before any of the flies made their eſcape, it might have contained about twenty. In theſe minute cells with the living flies, or whence they had made their eſcape, were ſmall dry dark-coloured compreſſed grains, which may be the dried excrements of the flies.

NOTE *by the* PRESIDENT.

The *Hindus* have ſix names for *Lac*; but they generally call it *Lácſhà* from the *multitude* of ſmall inſects, who, as they believe, diſcharge it from their ſtomachs, and at length deſtroy the tree on which they form their colonies: a fine *Pippala* near *Criſhnanagar* is now almoſt wholly deſtroyed by them.

XXV. *The Seventh Anniverſary Diſcourſe, delivered to the Society, Feb.* 25, 1790. *By the* PRESIDENT.

OF the Empire of China, the preſident does not mean to aſſign the exact limits; but he takes it in the uſual acceptation of geographers. The word *China* is well known to the people whom we call the *Chineſe*, but the learned among them never apply it to themſelves or their country. Themſelves, according to father *Viſdelou*, they term the *people of* HAN, or of ſome other illuſtrious family; and their country they call *Chúm-cuë*, or the *Central Kingdom*, repreſenting it in their ſymbolical characters by a parallelogram exactly biſected; at other times they diſtinguiſh it by the words *Tien-hia*, or *What is under Heaven*, meaning *all that is valuable on Earth*. Without diſcuſſing the comparative rank of the Chineſe among civilized nations, the preſident means to confine himſelf to the queſtion, "Whence came the ſingular people, who long had governed China, before they were conquered by the Tartars?" On this problem four opinions have been advanced. 1. That they are an original race, who have dwelt for ages, if not from eternity, in the land they now poſſeſs. 2. That they ſprang from the ſame ſtock with the Arabs and Hebrews. This is chiefly held by the miſſionaries. 3. The opinion of the Arabs and of *M. Pauw*, is, that they were originally Tartars deſcending in clans from the ſteeps of Imaus. 4. The Brahmans hold that the *Chinas* (ſo they are named in Sanſcrit) were Hindus of the *Cſhatriya* or military claſs, who, abandoning the privileges of their tribe, wandered in different bodies to the north-eaſt of Bengal, and deſerting the rites of their anceſtors, eſtabliſhed ſeparate principalities, which were afterwards united in the plains and vallies now poſſeſſed by them. If any one of the three latter ſuppoſitions be true, the former muſt be renounced; but of theſe, the firſt is utterly without ſupport or probability, no human creatures being more different than a Chineſe and an Arab. The ſecond can at preſent be no otherwiſe diſproved, than by inſiſting on the total diſſimilarity of the Tartars and Chineſe in manners and arts; but it muſt neceſſarily fall to the ground, if the third be eſtabliſhed, namely, that the firſt Chineſe were of Indian race; to the diſcuſſion of which point the preſident devotes the remainder of his diſcourſe.

In the *Sanſcrit* inſtitutions of MENU is found the following paſſage. "Many families of the military claſs, having gradually abandoned the ordinances of the *Véda*, and the company of Brahmans, lived in a ſtate of degradation; as the people of *Pundraca* and *Odra*, thoſe of *Dravira* and *Cambója*, the *Yavanas* and *Sacas*, the *Páradas* and *Pahlavas*, the *Chínas* and ſome other nations." It ſeems that this teſtimony would decide the queſtion, if we could be ſure that the word *China* ſignified a *Chineſe*; and this all the *Pandits* whom the preſident ſeparately conſulted aſſured him it did, and that the *Chînas* ſettled in a fine country to the north-eaſt of *Gaur*, and to the eaſt of *Câmarûp* and *Népàl*; that they have long been, and ſtill are, famed as ingenious artificers; and that they had themſelves ſeen old Chineſe idols, which bore a manifeſt relation to the primitive religion of India, before BUDDHA's appearance. A well informed *Pandit* ſhewed him a Sanſcrit book in Caſhimirian letters, revealed, as he ſaid, by SIVA himſelf, from which he read a whole chapter on the heterodox opinions of the *Chinas*, who were divided, according to the author, into near two hundred clans. He alſo, in a map of Aſia, pointed to the north-weſtern provinces of China, as the place where the *Chinas* firſt eſtabliſhed themſelves; but added, that *Mahâchîna* extended to the eaſtern and ſouthern ocean. The preſident believes, nevertheleſs, that the Chineſe empire, as we now call it, was not formed when the laws of MENU were collected; for which belief, ſo repugnant to the general opinion, he offers the following reaſons. The poems of *Câlîdâs* were compoſed before the beginning of our era; but it is clear that the *Râmâyan* and *Mahâbhârat* were conſiderably older than thoſe poems; and it appears from the ſtyle and metre of the *Dherma Sâſtra* revealed by MENU, that it was reduced to writing long before the age of *Válmuc*, or *Vyáſa*, the ſecond of whom names it with applauſe. The compiler of thoſe laws may therefore be fairly placed between one thouſand and fifteen hundred years before Chriſt; but in the twelfth century before our era, the Chineſe empire was in its cradle. This fact it is neceſſary to prove, and the preſident's firſt witneſs is CONFUCIUS himſelf. In the ſecond part of his book entitled *Lúnyú*, he declares that, " although he, like other men, could relate, as mere leſſons of morality, the hiſtories of the firſt and ſecond imperial houſes, yet, *for want of evidence*, he could give no certain account of them." Now, if the Chineſe themſelves do not even pretend, that any hiſtorical monument exiſted, in the age of *Confucius*, preceding the riſe of their third dynaſty, about eleven hundred years before Chriſt, we may juſtly conclude that the reign of VU'VAM was in the infancy of the empire, which hardly grew to maturity till ſome ages after that prince.

" It was not till the eighth century before the birth of Our Saviour, that a ſmall kingdom was erected in the province of *Shen-sí*, the capital of which ſtood nearly in the *thirty-fifth* degree of northern latitude, and about *five* degrees to the weſt of *Si-gan*: both the country and its metropolis were called *Chín*, and the dominion of its princes was gradually extended to the eaſt and weſt. A king of *Chín*, who makes a figure in the *Shâhnáma* among the allies of AFRA'SIYA'B, was, I preſume, a ſovereign of the country juſt mentioned; and the river of *Chín*, which the poet frequently names as the limit of his eaſtern geography, ſeems to have been the *Yellow River*, which the *Chineſe* introduce at the beginning of their fabulous annals. I ſhould be tempted to expatiate on ſo curious a ſubject; but the preſent occaſion allows nothing ſuperfluous, and permits me only to add, that MANGUKHA'N died in the middle of the thirteenth century, before the city of *Chín*, which was afterwards taken by KUBLAI; and that the poets of *Irán* perpetually allude to the diſtricts around it which they celebrate, with *Chegil* and *Khoten*, for a number of muſk-animals roving on their hills. The territory of *Chín*, ſo called by the old *Hindus*, by the *Perſians*, and by the *Chineſe* (while the *Greeks* and *Arabs* were obliged, by their defective articulation, to miſcall it *Sín)*, gave its name to a race of Emperors, whoſe tyranny made their memory ſo unpopular, that the modern inhabitants of *China* hold the word in abhorrence, and ſpeak of themſelves as the people of a milder and more virtuous dynaſty; but it is

highly

highly probable that the whole nation deſcended from the *Chînas* of Menu, and mixing with the *Tartars*, by whom the plains of *Honan* and the more ſouthern provinces were thinly inhabited, formed by degrees the race of men whom we now ſee in poſſeſſion of the nobleſt empire in *Aſia*.

" In ſupport of an opinion, which I offer as the reſult of long and anxious enquiries, I ſhould regularly proceed to examine the language and letters, religion and philoſophy, of the preſent *Chineſe*, and ſubjoin ſome remarks on their ancient monuments, on their ſcience, and on their arts, both liberal and mechanical: but their ſpoken *language*, not having been preſerved by the uſual ſymbols of articulate ſounds, muſt have been for many ages in a continual flux; their *letters*, if we may ſo call them, are merely the ſymbols of ideas; their popular *religion* was imported from *India* in an age comparatively modern; and their *philoſophy* ſeems yet in ſo rude a ſtate, as hardly to deſerve the appellation: they have no *ancient monuments*, from which their origin can be traced even by plauſible conjecture; their *ſciences* are wholly *exotic*, and their *mechanical arts* have nothing in them characteriſtic of a particular family; nothing which any ſet of men, in a country ſo highly favoured by nature, might not have diſcovered and improved. They have, indeed, both national muſic and national poetry, and both of them beautifully pathetic; but of painting, ſculpture, or architecture, as arts of imagination, they ſeem (like other *Aſiaticks*) to have no idea. Inſtead, therefore, of enlarging ſeparately on each of thoſe heads, I ſhall briefly enquire, how far the literature and religious practices of *China* confirm or oppoſe the propoſition which I have advanced.

" The declared and fixed opinion of M. de Guignes, on the ſubject before us, is nearly connected with that of the *Brâhmans:* he maintains, that the *Chineſe* were emigrants from *Egypt*; and the *Egyptians*, or *Ethiopians* (for they were clearly the ſame people), had indubitably a common origin with the old natives of *India*, as the affinity of their languages, and of their inſtructions, both religious and political, fully evinces; but that *China* was peopled a few centuries before our era by a colony from the banks of the *Nile*, though neither *Perſians* nor *Arabs*, *Tartars* nor *Hindus*, ever heard of ſuch an emigration, is a paradox, which the bare authority even of ſo learned a man cannot ſupport; and ſince reaſon grounded on facts can alone decide ſuch a queſtion, we have a right to demand clearer evidence and ſtronger arguments than any that he has adduced. The hieroglyphics of *Egypt* bear, indeed, a ſtrong reſemblance to the mythological ſculptures and paintings of *India*, but ſeem wholly diſſimilar to the ſymbolical ſyſtem of the *Chineſe*, which might eaſily have been invented (as they aſſert) by an individual, and might very naturally have been contrived by the firſt *Chînas*, or out-caſt *Hindus*, who either never knew, or had forgotten, the alphabetical characters of their wiſer anceſtors. As to the table and buſt of Isis, they ſeem to be given up as modern forgeries; but, if they were indiſputably genuine, they would be nothing to the pnrpoſe; for the letters on the buſt appear to have been deſigned as alphabetical; and the fabricator of them (if they really were fabricated in *Europe*) was uncommonly happy, ſince two or three of them are exactly the ſame with thoſe on a metal pillar yet ſtanding in the north of *India*. In *Egypt*, if we can rely on the teſtimony of the *Greeks*, who ſtudied no language but their own, there were two ſets of alphabetical characters; the one *popular*, like the various letters uſed in our *Indian* provinces; and the other *ſacerdotal*, like the *Dêvanâgarì*, eſpecially that form of it which we ſee in the *Véda:* beſides which, they had two ſorts of *ſacred ſculpture*;

ture; the one ſimple, like the figures of BUDDHA and the three RA'MAS; and the other allegorical, like the images of GANE'SA, or *Divine Wiſdom*, and ISA'NI', or *Nature*, with all their emblematical accompaniments: but the *real character* of the *Chineſe* appears wholly diſtinct from any *Egyptian* writing, either myſterious or popular; and as to the fancy of M. DE GUIGNES, that the complicated ſymbols of *China* were at firſt no more than *Phenician* monograms, let us hope, that he has abandoned ſo wild a conceit, which he ſtarted probably with no other view than to diſplay his ingenuity and learning.

"We have ocular proof, that the few radical characters of the *Chineſe* were originally (like our aſtronomical and chymical ſymbols) the pictures or out-lines of viſible objects, or figurative ſigns for ſimple ideas, which they have multiplied by the moſt ingenious combinations and the livelieſt metaphors; but as the ſyſtem is peculiar, I believe, to themſelves and the *Japaneſe*, it would be idle and oſtentatious to enlarge on it at preſent; and, for the reaſons already intimated, it neither corroborates nor weakens the opinion which I endeavour to ſupport. The ſame may as truly be ſaid of their *ſpoken* language; for, independently of its conſtant fluctuation during a ſeries of ages, it has the peculiarity of excluding four or five ſounds which other nations articulate, and is clipped into monoſyllables, even when the ideas expreſſed by them, and the written ſymbols for thoſe ideas, are very complex. This has ariſen, I ſuppoſe, from the ſingular habits of the people; for though their common tongue be ſo *muſically* accented as to form a kind of recitative, yet it wants thoſe *grammatical* accents, without which all human tongues would appear monoſyllabic: thus *Amita*, with an accent on the firſt ſyllable, means, in the *Sanſcrit* language, immeaſurable; and the natives of *Bengal* pronounce it *Omito*; but when the religion of BUDDHA, the ſon of *Máyá*, was carried hence into *China*, the people of that country, unable to pronounce the name of their new God, called him *Foe*, the ſon of *Moye*, and divided his epithet *Amita* into three ſyllables O-MI-TO, annexing to them certain ideas of their own, and expreſſing them in writing by three diſtinct ſymbols. We may judge from this inſtance, whether a compariſon of their ſpoken tongue with the dialects of other nations can lead to any certain concluſion as to their origin; yet the inſtance which I have given ſupplies me with an argument from analogy, which I produce as conjectural only, but which appears more plauſible the oftener I conſider it. The BUDDHA of the *Hindus* in unqueſtionably the FOE of *China*; but the great progenitor of the *Chineſe* is alſo named by them FO-HI, where the ſecond monoſyllable ſignifies, it ſeems, a *Victim*: now the anceſtor of that military tribe whom the *Hindus* call the *Chandravanſa*, or children of the MOON, was, according to their *Purânas* or legends, BUDDHA, or the genius of the planet *Mercury*, from whom, in the *fifth* degree, deſcended a prince named DRUHYA; whom his father YAYA'TI ſent in exile to the eaſt of *Hinduſtân*, with this imprecation, "May thy progeny be ignorant of the *Veda*!" The name of the baniſhed prince could not be pronounced by the modern *Chineſe*; and though I dare not conjucture, that the laſt ſyllable of it has been changed into YAO, I may neverthelеſs obſerve, that YAO was the *fifth* in deſcent from FO-HI, or at leaſt the fifth mortal in the firſt imperial dynaſty; that all *Chineſe* hiſtory before him is conſidered, by the *Chineſe* themſelves, as poetical or fabulous; that his father TI-CO, like the *Indian* king YAYA'TI, was the firſt prince who married ſeveral women; and that FO-HI, the head of their race, appeared, ſay the *Chineſe*, in a province of the weſt, and held his court in the territory of *Chín*, where the rovers mentioned by the

India legiſlator are ſuppoſed to have ſettled. Another circumſtance in the parallel is very remarkable: according to Father De Premare, in his Tract on *Chineſe* Mythology, the mother of Fo-hi was the *daughter of Heaven*, ſurnamed *Flower-loving*; and as the nymph was walking alone on the bank of a *river* with a ſimilar name, ſhe found herſelf on a ſudden encircled by a *rainbow*; ſoon after which ſhe became pregnant, and at the end of twelve years was delivered of a ſon radiant as herſelf, who, among other titles, had that of Su'i, or *Star of the Year*. Now, in the mythological ſyſtem of the *Hindus*, the nymph Ro'hini', who preſides over the fourth lunar manſion, was the favourite miſtreſs of So'ma, or the *Moon*, among whoſe numerous epithets, we find *Cumudanáyaca*, or *delighting in a* ſpecies of *water-flower*, that bloſſoms at night; and their offspring was Budha, regent of a planet, and called alſo, from the names of his parents, Rauhine'ya or Saumya. It is true, that the learned Miſſionary explains the word Su'i by Jupiter; but an exact reſemblance between two ſuch fables could not have been expected; and it is ſufficient for my purpoſe that they ſeem to have a family likeneſs. The God Budha, ſay the *Indians*, married Ila', whoſe father was preſerved in a miraculous ark from an univerſal deluge: now, although I cannot inſiſt with confidence, that the *rainbow* in the *Chineſe* fable alludes to the *Moſaick* narrative of the Flood, nor build any ſolid argument on the divine perſonage Niu-va, of whoſe character, and even of whoſe ſex, the hiſtorians of *China* ſpeak very doubtfully; I may, nevertheleſs, aſſure you, after full enquiry and conſideration, that the *Chineſe*, like the *Hindus*, believe this earth to have been wholly covered with water, which, in works of undiſputed authenticity, they deſcribe as *flowing abundantly, then ſubſiding, and ſeparating the higher from the lower age of mankind*; that the *diviſion of time*, from which their poetical hiſtory begins, juſt preceded the appearance of Fo-hi on the mountains of *Chín*, but that the great *inundation*, in the reign of Yao, was either confined to the low-lands of his kingdom, if the whole account of it be not a fable, or if it contain any alluſion to the Flood of Noah, has been ignorantly miſplaced by the *Chineſe* Annaliſts.

" The importation of a new religion into *China*, in the firſt century of our Era, muſt lead us to ſuppoſe, that the former ſyſtem, whatever it was, had been found inadequate to the purpoſe of reſtraining the great body of the people from thoſe offences againſt conſcience and virtue which the civil power could not reach; and it is hardly poſſible that, without ſuch reſtrictions, any government could long have ſubſiſted with felicity; for no government can long ſubſiſt without equal juſtice, and juſtice cannot be adminiſtered without the ſanctions of religion. Of the religious opinions entertained by Confucius and his followers we may glean a general notion from the fragments of their works tranſlated by Couplet: they profeſſed a firm belief in the Supreme God, and gave a demonſtration of his Being, and of his Providence, from the exquiſite beauty and perfection of the celeſtial bodies, and the wonderful order of nature in the whole fabric of the viſible world. From this belief they deduced a ſyſtem of Ethicks, which the philoſopher ſums up in a few words at the cloſe of the *Lúnyù*: " He," ſays Confucius, " who ſhall be fully perſuaded, that the Lord of " Heaven governs the Univerſe, who ſhall in all things chuſe moderation, who ſhall " perfectly know his own ſpecies, and ſo act among them, that his life and manners " may conform to his knowledge of God and Man, may be truly ſaid to diſcharge " all the duties of a ſage, and to be far exalted above the common herd of the human " race." But ſuch a religion and ſuch morality could never have been general; and we find, that the people of *China* had an ancient ſyſtem of ceremonies and ſuperſtitions, which the government and the philoſophers appear to have encouraged, and which has an apparent affinity with ſome parts of the oldeſt *Indian* worſhip: they believe in the agency of genii, or tutelary ſpirits, preſiding over the ſtars and the clouds, over lakes and rivers, mountains, valleys, and woods, over certain regions and towns, over all the elements (of which, like the *Hindus*, they reckon *five*), and particularly over *fire*, the moſt brilliant of them: to thoſe deities they offered victims on high places; and the following paſſage from the *Shí-cin*, or *Book of Odes*, is very much in the ſtyle of the *Bráhmans*: "Even they who perform a ſacrifice with due reverence "cannot perfectly aſſure themſelves, that the divine ſpirits accept their oblations; "and far leſs can they who adore the Gods with languor and oſcitancy clearly per-"ceive their ſacred illapſes."

Theſe are imperfect traces indeed, but they are traces of an affinity between the religion of MENU and that of the *Chinás*, whom he names among the apoſtates from it. M. LE GENTIL, obſerved, he ſays, a ſtrong reſemblance between the funeral rites of the *Chineſe* and the *Sráddha* of the *Hindus*; and M. BAILLY, after a learned inveſtigation, concludes, that "even the puerile and abſurd ſtories of the *Chineſe* fabu-"liſts contain a remnant of ancient *Indian* hiſtory, with a faint ſketch of the firſt "*Hindu* ages."

As the *Bauddhas*, indeed, were *Hindus*, it may naturally be imagined, that they carried into *China* many ceremonies practiſed in their own country; but the *Bauddhas* poſitively forbad the immolation of cattle; yet we know that various animals, even bulls and men, were anciently ſacrificed by the *Chineſe*; beſides which we diſcover many ſingular marks of relation between them and the old *Hindus*: as in the remarkable period of *four hundred and thirty-two thouſand*, and the cycle of *ſixty*, years; in the predilection for the myſtical number *nine*; in many ſimilar faſts and great feſtivals, eſpecially at the ſolſtices and equinoxes; in the juſt mentioned obſequies, conſiſting of rice and fruits, offered to the manes of their anceſtors; in the dread of dying childleſs, leſt ſuch offering ſhould be intermitted; and, perhaps, in their common abhorrence of *red* objects, which the *Indians* carried ſo far, that MENU himſelf, where he allows a *Bráhman* to trade, if he cannot otherwiſe ſupport life, abſolutely forbids "his trafficing in any ſort of *red* cloths, whether linen or woollen, or made "of woven bark."

"All the circumſtances which have been mentioned under the two heads of *literature* and *religion* ſeem collectively to prove (as far as ſuch a queſtion admits proof) that the *Chineſe* and *Hindus* were originally the ſame people: but having been ſeparated near four thouſand years, have retained few ſtrong features of their ancient conſanguinity, eſpecially as the *Hindus* have preſerved their old language and ritual, while the *Chineſe* very ſoon loſt both; and the *Hindus* have conſtantly intermarried among themſelves, while the *Chineſe*, by a mixture of *Tartarian* blood from the time of their firſt eſtabliſhment, have at length formed a race diſtinct in appearance both from *Indians* and *Tartars*."

A ſimilar diverſity, the preſident ſuppoſes, has ariſen from ſimilar cauſes between the people of *China* and *Japan*; concerning which laſt nation he gives hopes of very full information from the expected work of *M. Titſingh*, in addition to that we already poſſeſs from *Kæmpfer*. From what we already know, however, he thinks it ſufficiently apparent that the Japaneſe are a branch of the ſame ancient ſtem with the Chineſe. Of this the proofs are, that the former have adopted all the ſingular literary ſyſtems of the latter; and that the Hindu or Egyptian idoltary has prevailed in Japan from the earlieſt ages, as appears from the figures of their idols, particularly that of the *Goddeſs with many arms* repreſenting the powers of nature, the Isis of Egypt, and the Isa'ni or Isi of India.

The preſident thus concludes his diſſertation. "Having now ſhewn, in five diſcourſes, that the *Arabs* and *Tartars* were originally diſtinct races, while the *Hindus*, *Chineſe*, and *Japaneſe*, proceeded from another ancient ſtem, and that all the three ſtems may be traced to *Iràn*, as to a common centre, from which it is highly probable, that they diverged in various directions about four thouſand years ago, I may ſeem to have accompliſhed my deſign of inveſtigating the origin of the *Aſiatick* nations; but the queſtions which I undertook to diſcuſs are not yet ripe for a ſtrict analytical argument; and it will firſt be neceſſary to examine with ſcrupulous attention all the detached or inſulated races of men, who either inhabit the borders of *India*, *Arabia*, *Tartary*, *Perſia*, and *China*, or are interſperſed in the mountainous and uncultivated parts of thoſe extenſive regions.

"To this examination I ſhall, at our next Annual Meeting, allot an entire Diſcourſe; and if, after all our enquiries, no more than *three* primitive races can be found, it will be a ſubſequent conſideration, whether thoſe three ſtocks had one common root, and, if they had, by what means that root was preſerved amid the violent ſhocks which our whole globe appears evidently to have ſuſtained."

XXVI. *Tranſlation of an Inſcription in the Maga Language, found in a Cave near Iſlàmabad. Communicated by* John Shore, *Eſq.*

THE ſubſtance of this inſcription is that, on the 14th of Màgha 194, Chandi Lah Raja cauſed a cave to be dug, and depoſited therein various images, &c. over which he erected a place of religious worſhip for the *Magas*, in honour of the deity.

God ſent in the world *Buddha Avatar* to inſtruct the ſteps of angels and men, the circumſtances of whoſe miraculous birth is given at large, his marriage, and return to his own country.

XXVII. *A Supplement to the Eſſay on Indian Chronology. By the* President.

A Paſſage in the Súrya Siddhánta, concerning the places of the colures in the times of Varáha, compared with their poſition in the age of a certain Muni, or Indian Philoſopher, appears to afford evidence of two actual obſervations, by which the chronology of the Hindus may with ſufficient degree of probability be aſcertained.

It runs thus. "Certainly the ſouthern ſolſtice was once in the middle of *Aſléſhà*, the "northern in the firſt *degree* of *Dhaniſht'hà*, by what *is* recorded in former *Sáſtras*. At "preſent one ſolſtice is in the firſt *degree* of *Carcata*, and theother in the firſt of *Macara*: "that which *is* recorded, not appearing, a change *muſt have happened*; *and* the proof "ariſes from ocular demonſtration; *that is*, by obſerving the remote object and its

" marks at the riſing or ſetting of the ſun, or by the marks, in a large *graduated*
" circle, of the ſhadow's ingreſs and egreſs. The ſun, by turning back without
" having reached *Macara*, deſtroys the ſouth and the weſt; by turning back without
" having reached *Carcata*, the north and eaſt. By returning, when he has juſt paſſed the
" ſummer ſolſtitial point, he makes wealth ſecure and grain abundant, ſince he moves
" thus according to nature; but the ſun, by moving unnaturally, excites terrour."

The 1ſt January 1790 was in the year 4891 of the Caliyuga, or fourth period, when the equinoctial points were in the firſt degrees of Meſha and Tula. Varaha lived confeſſedly, when the Caliyuga was far advanced, and as he found by actual obſervation that the ſolſtitial points were in the firſt degrees of Carcata and Macara, the equinoctial points were in the firſt of Meſha and Tula. He lived therefore in the year 3600 of the fourth Indian period, or 1291 years before 1ſt January 1790. This date correſponds with the ayananſa; for 19°..21′..54″ is the preceſſion of the equinoxes in 1291 years, taking the Hindu computation of 54′ annually, by the Newtonian of 50″ annually, it is 17°..55′..50″ which gives us more nearly in our own ſphere, the firſt degree of Meſha in that of the Hindus. By the obſervations in the older Saſtras, the equinox had gone back 23°..20′, or 1680 years had elapſed between the age of the Muni and Varaha. The former obſervation muſt therefore have been made about 2971 years before 1ſt January 1790 or 1181 before Chriſt.

The commentary contains information of the greateſt importance.

" The ſeaſon of *Siſira* is from the firſt of *Dhaniſht'hà* to the middle of *Révatì*; that
" of *Vaſanta* from the middle of *Révatì* to the end of *Róhinì*; that of *Gríſhma* from
" the beginning of *Mrigas'iras* to the middle of *Aſléſhà*; that of *Verſhà* from the middle
" of *Aſléſhà* to the end of *Haſta*; that of *Sarad* from the firſt of *Chitrà* to the middle
" of *Jyéſht'hà*; that of *Hémanta* from the middle of *Jyéſht'hà* to the end of *Sravanà*."

This account of the ſix Indian ſeaſons places the ſolſtitial points, as Varaha has aſſerted, in the firſt degree of Dhaniſht'hà and 6°..40′ of Aſléſhà, the equinoctial points being in the tenth degree of Bharanì, and 3°..20′ of Viſác'ha. In the time of Varaha the ſolſtitial points were in the tenth degree of Punarvaſu, and 3°..20′ of Uttaráſhàrà, the equinoctial being in the firſt of Aſwini and 6°..40′ of Chitra. Paráſara does not uſe in the paſſage, the phraſe at preſent, which occurs in the text of Varaha, ſo that the colures might have been aſcertained before his time, and as in our ſigns a conſiderable change might have taken place without any alteration of the phraſes. Paráſara muſt have written within twelve centuries before our era, and this leads to important conſequences in the ſyſtem of Indian hiſtory.

A compariſon may be eaſily made between the colures of Paráſara and thoſe aſcribed by Eudoxus to Chiron, the inſtructor of the Argonauts. From the fourth Pythian ode of Pindar, it appears that fifteen complete generations had intervened between the voyage of Jaſon and the emigration of Battus; ſuppoſing three generations equal to a hundred or a hundred and twenty years, that voyage muſt be placed at leaſt five or ſix hundred years before the time fixed by Newton, for the building of Cyrene by Battus, that is, eleven or twelve hundred and thirty three years before Chriſt. If Pindar means that Arceſilas his contemporary was the eighth in deſcent from Battus, we ſhall draw nearly the ſame concluſion. Pindar was forty years old at the battle of Salamis, five hundred and twenty years before our era; allowing ſix or ſeven hundred years to twenty-three generations, the voyage of Jaſon may be placed about 1170 years before Chriſt, or forty-five years before the beginning of the Newtonian Chronology.

From the deſcription of the old colures by Eudoxus, it appears, that ſome rude obſervations were made about 937 years before the Chriſtian epoch. If the cardinal points had receded from thoſe colures 36°..29′..10″ at the beginning of the year 1690, and 37°..52′..30″ on the firſt of January, in the preſent year, they muſt have gone back 3°..23′..20″ between the obſervation of Paráſara and that recorded by Eudoxus, or 244 years muſt have elapſed between them.

The laſt couplets of Varaha, though merely aſtrological, imply, that when the ſolſtices are not in the firſt degrees of Carcata and Macara, the motion of the ſun is contrary to nature. "When the ſun returns, not having reached Dhaniſh'tà in the "northern ſolſtice, or not having reached Aſléſhà in the ſouthern, then let a man "feel great apprehenſion of danger." Paráſara himſelf entertained the ſame opinion. "When having reached the end of Sravanà in the northern path or half of Aſléſhà "in the ſouthern, he ſtill advances, it is a cauſe of great fear." Whatever might be the ground of Varaha's aſtrological rule, we may collect from his aſtronomy, that the ſolſtice had receded at leaſt 23°..20′ before his time, and that of Paráſara. To Bailly's queſtion, why did the Hindus eſtabliſh the beginning of the preceſſion in the year of Chriſt 499, it may be anſwered; becauſe in that year the vernal equinox was obſerved in the beginning of their ecliptic; and ſince it muſt have had the ſame poſition in the firſt year of the Caliyuga, they were induced to fix the beginning of their fourth period, 3600 years before the time of Varaha, and to account for Paráſara's obſervation, by ſuppoſing an ulpáta or prodigy.

The Bráhmans agree, that only one Paráſara is named in their ſacred records, that he compoſed the aſtronomical book above mentioned, was the grandſon of Vaſiſhta another aſtronomer, who was the preceptor of Rama, king of Ayódhà; that he was the father of Vyáſa, by whom the Védas were arranged in form: ſo that Paráſara might have lived till the beginning of the Caliyuga, placed by the Hindus from a miſtaken notion of the vibration of the equinoctial points 1920 years too early. Since Vaſiſhta is more than once named in the Mánavíſanhità, we may be ſure, that the laws aſcribed to Menu could not have received their preſent form above three thouſand years ago.

The age and functions of Garga lead to more intereſting conſequences. He was the officiating prieſt of Chriſhna, and his daughter is addreſſed in the Véda itſelf. Chriſhna praiſes Vyáſa in the Gitá. The Bráhmans allow theſe facts, and we may hence reaſonably infer, that if Vyáſa was not the compoſer of the Védas, he added at leaſt ſomething of his own to the ſcattered fragments of a more ancient work. But whatever may be the comparative antiquity of the Hindu ſcriptures, the Moſaick and Indian chronologies are perfectly conſiſtent. Menu, ſon of Brahma, was the Adima, or firſt created mortal, our Adam. Menu, child of the ſun, preſerved with ſeven others in an ark from a deluge, was our Noah. Hiranyacaſipu, the giant with a golden axe, and Vali or Bali, impious monarchs, were probably our Nimrod and Belus. The three Ramas were different repreſentations of the Greek Bacchus, and either the Rama of ſcripture, or his colony perſonified, or the ſun firſt adored by his idolatrous family. A conſiderable emigration happened about twelve centuries before Chriſt, from Chaldea into Greece, Italy and India. Sácya or Síſak, about two hundred years after Vyáſa, imported into this country the mild hereſy of the ancient Bauddhas, and the dawn of true Indian hiſtory appears only three or four centuries before the Chriſtian era, the preceding ages being clouded with fable.

It is remarkable that Rieſha in the Sanſcrit means a conſtalletion and a bear, ſo that Maharcſha may be either a great bear or a great conſtellation. From this comes perhaps the Megas arctos of the Greeks: for the wild American juſtly obſerved, that a bear with a very long tail could never have occurred to any one who had ſeen the animal.

XXVIII. *On the Spikenard of the Ancients.* *By the* PRESIDENT.

THAT odoriferous plant called *Indian Spikenard*, by the confeſſion of all modern botaniſts, was an unknown article. In order to trace it by information from the natives, it was neceſſary to aſcertain its name in ſome Aſiatic language. The word *nard* is originally Perſian, and evidently means part of a vegetable, though what part does not exactly appear. The Arabic word *ſumbul* which means an *ear* or *ſpike*, however, has long been ſubſtituted for it; and there is no doubt that by the *ſumbul* of *India* the Muſelmans underſtand the ſame plant with the *nard* of Ptolemy, and the *nardoſtachys* or *ſpikenard* of Galen. This further appears to be the *Jatâmânsì* of the Hindus, or *Spikenard* of our Druggiſts, which conſiſts of withered ſtalks and ribs of leaves, cohering in a bundle of yellowiſh brown capillary fibres, and conſtituting a ſpike about the ſize of a finger. The *Jatâmânsì* was met with in Butan, by Mr. Saunders, who pronounces it a ſpecies of the *Baccharis*, and meaſures have been taken to get ſome growing plants from thence, in order to aſcertain this point. Meantime the *Jatâmânsì* of the mountains of Nepal has been procured and planted in the garden at Gaya, whence a drawing and deſcription have been ſent by Mr. Burt. Before the preſident proceeds to this, he endeavours to obviate a prejudice concerning the natural order of the ſpikenard, which Linnæus ſuppoſed to be a graſs, of the genus *Andropogon*. There are various odoriferous graſſes in the eaſt, ſome of which have relation to the word *nâr*; but he is of opinion that the *nardum* of the Romans was a generic word, meaning what we now call *âtar*, or an Indian eſſence in general. He was not able to meet with any graſs reſembling the *Jatâmânsì* or real *ſpikenard*. Mr. Burt's deſcription of this plant has afforded the following natural characters.

AGGREGATE.

Cal. Scarce any. *Margin*, hardly diſcernible.
Cor. One petal. *Tube* ſomewhat gibbous. *Border* five cleft.
Stam. Three *Anthers*.
Piſt. *Germ* beneath. One *Style* erect.
Seed, Solitary, crowned with a pappus.
Root, Fibrous.
Leaves, Hearted, fourfold; *radical* leaves petioled.

Hence it appears to be a ſpecies of VALERIAN, which he thus deſcribes in the Linnean ſtyle. VALERIANA JATA'MA'NSI *floribus triandris, foliis cordatis quaternis, radicalibus petiolatis.*

APPENDIX I. ABSTRACT *of a* METEOROLOGICAL REGISTER, *kept at* Calcutta, 1784.

MONTH.	THERMOMETER.						Difference between morn. & mid-day heat.	BAROMETER.									Mean ſtate atmoſphere.			Moiſture.			appearance atmoſphere		Thunder No. times.	Winds.	
	Morning.		Noon.		Evening.			Morning.			Noon.			Evening.													
	Loweſt.	Higheſt.	Loweſt.	Higheſt.	Loweſt.	Higheſt.		Loweſt.	Higheſt.	Variation	Loweſt.	Higheſt.	Variation	Loweſt.	Higheſt.	Variation	temperature.	Weight.	Denſity.	Moiſture.	Rainy days.	Quant. rain.	Number clear days.	Cloudy do.		Point.	Force
February,	66	75	70	86	68	76	7										$74\frac{2}{3}$		700	6	8	4.2	3	26	6	S	2
March,	66	84	75	89	71	85	9										$79\frac{1}{3}$		692	5	3	1.8	16	15	3	S	3
April,	71	86	[illegible]7	97	79	87	8										$86\frac{1}{3}$		681	10	6	3.1	14	16	6	S	4
May,	75	85	82	93	74	88	8										$84\frac{1}{3}$		683	15	12	9.6	7	24	13	S	2
June,	77	84	80	90	78	86	4										83		686	25	14	17.4	1	29	5	SE	1
July,	77	84	77	90	78	85	4										83		686	25	20	15.	1	30	5	S&SE	1
Auguſt,	77	83	80	89	80	84	4	29.57	29.75	.18	29.56	29.75	.19	29.61	29.76	.15	$82\frac{2}{3}$	29.67	686	25	23	16.9	5	26	15	S&SE	1
September,	76	84	77	90	78	85	5	.72	.95	.23	.68	.90	.22	.75	.97	.22	$82\frac{1}{3}$	.81	690	24	12	11.3	10	20	5	S&SE	1
October,	74	83	77	90	76	85	7	.74	30.04	.30	.77	30.00	.23	.76	30.02	.26	$82\frac{2}{3}$	.91	692	2	3	.8	19	12	1	NW	1
November,	66	78	76	86	71	80	10	.60	.12	.52	.88	.05	.17	.92	.08	.16	76	30.00	702		1	.9	23	7		NW	1
December,	58	69	68	79	65	73	11	30.02	.17	.15	30.00	.14	.14	30.02	.17	.15	$68\frac{2}{3}$	.08	718		1	.05	26	5		NW	1
Jan. 1785,	57	70	69	78	64	74	11	29.98	.17	.19	29.97	.14	.17	.03	.17	.14	$66\frac{2}{3}$	.08	722				29	2		SW	2
Mean	70	$80\frac{5}{12}$	$76\frac{5}{12}$	88	$73\frac{6}{12}$	$82\frac{6}{12}$	$7\frac{4}{12}$	29.77	30.03	.26	29.81	30.00	.19	29.85	30.03	.18	79	29.92	695		105	81.0	154	212	59		2

ABSTRACT *of a* METEOROLOGICAL REGISTER, *kept at* Calcutta, 1785.

MONTH.	THERMOMETER.						Difference between morn. & mid-day heat.	BAROMETER.									Mean ſtate atmoſphere.			Moiſture.			appearance atmoſphere		Thunder No. times	Winds.	
	Morning.		Noon.		Evening.			Morning.			Noon.			Evening.													
	Loweſt.	Higheſt.	Loweſt.	Higheſt.	Loweſt.	Higheſt.		Loweſt.	Higheſt.	Utmoſt variation.	Loweſt.	Higheſt.	Variation	Loweſt.	Higheſt.	Variation	temperature.	weight.	Denſity.	Moiſture	No. rainy days	Quant. rain.	Nunber clear days.	Cloudy do.		Point.	Force.
January,	57	70	69	78	64	74	11	29.98	30.17	.19	29.97	30.14	.17	30.03	30.17	.14	$66\frac{2}{3}$	30.08	722				29	2		SW	2
February,	68	74	75	86	69	76	$8\frac{1}{2}$	.89	.14	.25	.89	.17	.28	29.96	.15	.19	75	.02	706		4	2.9	17	11	4	SW	1
March,	68	80	80	90	73	83	10	.85	.12	.27	.84	.10	.26	.86	.13	.27	79	29.95	698		3	0.5	20	11	5	S	3
April,	69	83	75	91	74	85	8	.70	29.97	.27	.68	29.92	.24	.74	29.97	.23	$82\frac{1}{2}$	.83	690		6	8.0	17	13	6	S	3
May,	79	87	87	94	80	89	7	.60	.96	.36	.53	.92	.39	.63	30.03	.30	86	.77	682		10	6.0	18	13	14	S	2
June,	79	84	80	90	79	85	3	.44	.70	.26	.40	.68	.28	.47	29.72	.26	83	.58	684		24	24.4	4	26	16	SE	1
July,	79	84	80	89	80	87	3	.44	.73	.29	.45	.67	.22	.47	.73	.26	83	.59	684		24	12.8	4	27	11	SE	1
Auguſt,	79	84	80	89	80	86	3	.50	.78	.28	.49	.72	.23	.57	.78	.26	83	.62	685		20	9.3	3	28	16	SE	1
September,	80	84	81	89	80	85	4	.62	.83	.21	.59	.82	.23	.66	.87	.21	83	.71	686		16	11.7	8	22	13	S	1
October,	77	84	82	88	79	85	4	.83	.98	.15	.81	.96	.15	.85	.98	.13	83	.91	691		7	1.4	21	10	4	NW	1
November,	67	80	74	85	71	82	5	.90	30.10	.20	.82	30.08	.26	.80	30.12	.32	75	.98	705		4	0.5	26	4	0		2
December,	63	70	71	76	66	73	7	.97	.09	.12	.90	.06	.16	.99	.10	.11	69	30.01	716				31				1
Tot. Mean	$72\frac{1}{12}$	$80\frac{1}{12}$	$77\frac{10}{12}$	$87\frac{1}{12}$	$74\frac{7}{12}$	$82\frac{6}{12}$	6	29.73	29.96	.24	29.70	29.94	.24	29.75	29.96	.22	77	29.84	696		118	77.5	198	167	89		2

APPENDIX. II.

A Synopſis of the different Caſes that may happen in deducing the Longitude of one Place from another by means of ARNOLD'S *Chronometers, and of finding the Rates when the Difference of Longitude is given. By Mr.* REUBEN BURROW.

THE Hindus have a practice which the writer of this paper recommends: they give two rules for the ſame operation, one couched in the ſhorteſt terms poſſible, and often in verſe, the other more at length as an explanation. The following rule is inſerted on account of its utility and eaſy application.

Let E = error of the watch from mean time at one place.
e = at another place.
T = time by watch at the 2d place when error was e.
D = difference of longitude between the places.
N = interval of mean time between the obſervations at the two places (found by taking the interval by the watch, and correcting it according to the eſtimated rate.)
r = rate of the watch, or what it gains or loſes in a day of mean time.

APPENDIX. III.

Memorandums concerning an old Building, in the Hadjipore Diſtrict, near the Gunduck River, &c. By Mr. REUBEN BURROW.

AFTER obſerving that the pyramids of Egypt, as well as thoſe lately diſcovered in Ireland, ſeem to have been intended for nothing more than images of Mahadeo; ſome of which pyramids are built of mud, and ſome of ſtone; Mr. Burrow ſays the largeſt building of this kind he ſaw in India, was about two days journey up the *Gunduck* river, which goes by the name of *Bheem Sain's Dewry*, but ſeems evidently intended for the well known image of *Mahadeo*, having been a cylinder placed upon the fruſtum of a cone for the purpoſe of being ſeen at a diſtance. From a rough meaſurement it appears, that the diameter of the cylindrical part is about 64 feet; the height 65 feet; height of the conic fruſtum 93 feet; diameter of the baſe 363 feet. Both are of brick, well burnt, and do not appear hollow. Mr. Burrow ſuggeſts that theſe buildings were intended to hold inſcriptions, but this pillar ſeems to have none whatſoever.

Mr. Burrow mentions a circumſtance which occurred while he was viewing the pyramids. Some of the natives were playing with *cowries*, on a diagram, formed by placing five points in a circular order, and joining every pair of alternate points by a line, forming a kind of pentagon; he had heard that a plate had been dug out of the earth in England with ſuch a figure on it, from whence he ſuggeſts an argument in favour of the identity of the Druids and Brahmans.

APPENDIX IV.

Obſervations of ſome of the Eclipſes of Jupiter's Satellites. *By Mr.* REUBEN BURROW.

THESE obſervations were made in various parts of India, and will be uſeful in determining their longitudes. The writer concludes, by making a remark that concerns both the buyers and makers of teleſcopes. The parts compoſing the object glaſs of an achromatic are in general ſo put together, that they cannot be taken aſunder: and the braſs part, that they are bedded in, by ſhooting a number of chymical ramifications between the glaſſes, renders a teleſcope in the courſe of a year of little or no ſervice. By making the object glaſs capable of being taken to pieces, or placing the parts into ſome other ſubſtance, this defect may be remedied.

APPENDIX V.

A Proof that the Hindus had the Binomial Theorem. *By Mr.* REUBEN BURROW.

THIS paper contains much miſcellaneous matter, and the proper ſubject lies in very ſmall compaſs. It is inferred that the Hindus were acquainted with the binomial theorem from the following queſtion, and its ſolution, originally written in Sanſcrit.

" A RAJA's palace had eight doors; now theſe doors may either be opened by one " at a time; or by two at a time; or by three at a time; and ſo on through the " whole, till at laſt all are opened together: it is required to tell the number of times " that this can be done;

" Set down the number of the doors, and proceed in order gradually decreaſing by " one to unity and then in a contrary order as follows.

8	7	6	5	4	3	2	1
1	2	3	4	5	6	7	8

" Divide the firſt number eight by the unit beneath it, and the quotient eight ſhews " the number of times that the doors can be opened by one at a time: multiply this " laſt eight by the next term ſeven, and divide the product by the two beneath it, " and the reſult twenty-eight is the number of times that two different doors may be " opened: multiply the laſt found twenty-eight by the next figure ſix, and divide the " product by the three beneath it, and the quotient fifty-ſix, ſhews the number of " times that three different doors may be opened: again this fifty-ſix multiplied by the " next five, and divided by the four beneath it, is ſeventy, the number of times that " four different doors may be opened: in the ſame manner fifty-ſix is the number of " fives that can be opened; twenty-eight the number of times that ſix can be opened: " eight the number of times that ſeven can be opened; and laſtly, one is the number " of times the whole may be opened together, and the ſum of all the different " times is 255."

The demonſtration is evident. Let $1 + 1$ be raiſed to a power of n dimenſions. The coefficient of the ſecond term is n the ſum of the roots, of the 2d. the ſum of the products of two of the roots, of the 3d. of three of the roots, and ſo on.

Mr. Burrow is of opinion, that the Hindu religion ſpread over the whole earth; that Stonehenge is one of the temples of Boodh; that our aſtronomy, aſtrology, arithmetic, holidays, games, &c. may be referred to the ſame original. The religious ceremonies of the papiſts are ſervile imitations of the Goſeigns and Fakeers, the Chriſtian aſcetics of the filthy Byraggys. The hell of the Hindus is purgatory. Popery and deiſm are ſimilar to the doctrines of Brahma and Boodh: the Brahmens were the authors of the Ptolemaick, the Boodhiſts of the Copernican ſyſtem. Theſe opinions may to many want confirmation, but we ſhall be obliged to Mr. Burrow for his promiſed tranſlations of the arithmetic and algebra of the Hindus. In them he may perhaps find farther proof of their acquaintance with the differential method which he attributes to them from the coincidence of ſome of their aſtronomical calculations, with thoſe made out by the differential method.

Mr. Burrow recommends permanent meridian lines to be drawn in high northern latitudes, to be compared in ſucceeding ages, and alſo marks to be cut in rocks by the ſea, to ſhew the proper level of the water. For he preſumes from the iſlands covered with ſhells in the Bay of Bengal, and the beds of large ſmooth pebbles, ſome hundred feet above the Ganges, that the ſea has been gradually retiring, and the ſituation of the poles has been changed. In the former ſituation of the equator, he imagines that the ſands of Tartary were inhabitable, the Siberian deſarts temperate, the rivers of Paradiſe went through India, China, Siberia, and into the Caſpian ſea reſpectively. This appears from a Brahmen map of the world in the Sanſcrit language.

P. S. A rock in the ſea near an iſland about ſeven miles to the ſouth of Cheduba, on the Aracan coaſt, whoſe top is eighteen feet above high water mark, is covered with ſmall rock oyſters, all of which were dead on February 2, 1782, except thoſe that were a foot above the high water mark of that day. Poſſibly naturaliſts may be able to tell the age of ſuch ſhells from their appearance, and thence form an eſtimate of the alteration of the level of the ſea. From a vague eſtimation of the trees, coaſts, ſhells, &c. it appears to ſubſide at the rate of about three inches a year.

New Memoirs of the Imperial and Royal Academy of Sciences and Belles Letters, of Bruſſels. Vol. I. *Part* II. *Hiſtory.*

A Geographico-Hiſtorical Diſſertation on the greater Tribes who inhabited the modern Belgium before the Empire of Auguſtus. By JOSEPH GHESQUIERE. *Written in* 1775.

IN the time of Cæſar, the limits of *Belgium* were much more extenſive than at preſent, reaching from the Seine to the Rhine on the coaſt, and ſtretching upwards ſo as to comprehend all the countries between the laſt river, and the Maes and Moſelle. The diminution it afterwards ſuffered on the eaſt, ſouth and weſt, was not compenſated by the addition of the Tranſrhenane provinces to the north, now compoſing the Dutch ſtates. Modern Belgium conſiſts of four Dutchies, one Marquiſate, ſeven Counties, five Lordſhips, and two Epiſcopal juriſdictions interpoſed between them. It is concerning the ancient inhabitants of theſe, and their limits, that the author means to treat.

Of theſe, the moſt celebrated according to Julius Cæſar, are the *Treviri*, the *Nervii* and their clients, the *Atrebates* and *Morini*, the *Menapii*, *Aduatici*, *Condruſi*, *Eburones*, *Cæreſi*, *Pœmani*, and *Segni*; to which may be added the *Batavi*. All theſe, except the *Atrebates* and *Morini*, migrated into Belgium from Germany, expelling the Gauls who before inhabited the country. To the German origin of the *Treviri* and *Nervii*, Strabo and Tacitus give their teſtimony. That the *Menapii* were Germans, appears from Cæſar, who ſays that all thoſe inhabiting the banks of the Rhine in his time were ſuch. The *Aduatici* are ſaid by Cæſar to have proceeded from the Teutones and Cimbri. The others are expreſsly called Germans by Cæſar. The *Batavi* are by Tacitus related to have been originally a party of Catti expelled from their country by a domeſtic quarrel.

So much for the origin of theſe tribes. Next as to their boundaries.

The *Morini*, according to Cæſar, poſſeſſed that part of the ſea-coaſt which is neareſt to Britain. Their country was therefore that part of the ancient dioceſe of Terouanne, which in 1566, was made the biſhoprick of Boulogne; containing St. Omer's, Ipres, Graveline, Bourbourg, Dunkirk, Calais, Dixmude, Neuport, &c.

The *Atrebates* touched on the ſouthern limits of the Morini, and bordered on the Nervii and Veromandui. They occupied the country of the preſent Arras, Douay, Valenciennes, Bouchain, Bethune, Lens, and the diſtrict between the Scarpe and the Scheld.

The *Nervii* may be concluded from Cæſar and Strabo, to have extended from the right bank of the Scheld to the Treviri, and perhaps ſouthward to the confines of the Rhemi. Their diſtrict was therefore included between the Scheld, Maes, and Haine, in which are at preſent Cambray, part of Valenciennes, Queſnoy, Maubeuge, Bavay, Landrecy, Aveſne, Chimay, Mons and Binche. It is uncertain whether it took in the ſite of Aloſt, Bruſſels, Vilvord and Mechlin, though probably the whole dioceſe of Cambray was within its limits. Who were the *clients of the Nervii* cannot be aſcertained.

The *Menapii* were conterminous on the ſea-coaſt with the Morini, and extended largely between the left bank of the Scheld, the Lis, and the ocean, occupying the greateſt part of the dioceſe of Tournay, and that of Bruges, or the preſent territory of part of Tournay, of Lille, Menin, Courtray, Oſtend, Bruges, Damme, Sluys, Deynſe, the northern part of Ghent, and the land of Waes. The author alſo ſuppoſes that the *Menapii* held the country near the Maes, and both banks of the lower Rhine, where are now the towns of Sandvliet, Bergen-op-Zoom, Steenbergen, Willemſtadt, Gertruydenberg, Breda, Turnhout, Eyndhoven, Cuyck, Grave, and Boiſleduc; and poſſibly the iſlands of Zeeland.

The *Aduatici* were neighbours to the Nervii, probably bordering on them in a line from Halle to Charleroy; thence their limits ſtretched to near Charlemont, taking in the diſtrict between the Maes and Sambre. They alſo occupied the tract from Namur to the Mehaign, and thence to Loo, Dieſt, Aerſchot, part of Louvain, and returning by Nivelle to Charleroy.

The limits of the Eburones on this ſide the Maes, ſeem to have run from Huy northwards between Loo and St. Tron, by Teſſenderloo, Hamont, and Weert to the

Maes; containing Tongres in the centre, Liege, Maeſtricht, Stockem, Maeſyck, Hoorn, Brey, &c. Their limits beyond the Maes probably extended from Ruremond to Ordingen on the Rhine, and thence bordered by theſe two rivers, ſtretched ſouthwards to the Aar, which flows into the Rhine at Lintz, and to the Ourt which empties into the Maes, including Limburg, Bonn, Aix la chapelle, Cologn, Juliers, Wyck, &c.

The *Treviri* appear from Cæſar to have had the Rhine for their eaſtern limit. To the north they touched the Pœmani, Condruſii, &c. who inhabited the northern part of the dutchy of Luxemburg. To the ſouth they croſſed the Moſelle. Their ſouth-eaſtern limit ſeems to have been near Reving in the foreſt of Ardenne. Thus they poſſeſſed the greateſt part of the dutchy of Luxemburg, as well as the country to the ſouth of it, about Montmedi, Thionville, &c.

The *Inſula Batavorum* from the account of Cæſar and other authors, appears to have had the following boundaries. Its ſouthern ſide was made by the Waal, which going off from the Rhine, runs into the Maes; and then by the latter river along the channel now called old Maes, which paſſes Heuſden and runs to Gertruydenberg, and ſo on by Hollandſdiep and Haringvliet, between the iſlands of Goeree and Voorn, to the ſea. Its weſtern ſide, by the ocean, as far as the entrance of the Rhine at Catwyck: its northern ſide, by the Rhine, proceeding along its northern branch, by Leyden and Utrecht, to its eaſtern termination near Schenck, where the Waal parts from it. The Batavians ſeem alſo to have occupied the country between the Waal and Maes, about the preſent Nimmegen, Batenburg, Cronenburg, and Cleves.

Obſervations on the Notitia Galliarum, publiſhed by Father SIRMOND: *by Father* DOM ANSELME BERTHOD, *a Religious Benedictine.*

THE writer firſt enquires into the time when the *Notitia Galliarum* of Sirmond was compiled. It has been uſually attributed to the reign of *Honorius*, which laſted from 395 to 423; but from the circumſtance, that it muſt have exiſted before *Arles* was a metropolitan city, he thinks it may be carried back with ſome certainty to the time of *Valentinian* II. who reigned from 388 to 392. He further finds from the *Notitia*, that when it was compoſed, *Baſil* was already ranked among the cities of the *Provincia Maxima Sequanorum*, whereas *Augſt*, its former capital under the name of *Auguſta Rauracorum*, was degraded to the rank of a Caſtellum. But it appears from Ammianus Marcellinus, that about 386 the capital of the *Rauraci* was ſtill in all its ſplendour. This leads him to ſome conjectures on the period when that capital was deprived of its rank and title, and to ſome remarks concerning metropolitan cities, which ſerve to ſhew the uſe to be made of the *Notitia* in eccleſiaſtical hiſtory.

Obſervations Bibliographical and Hiſtorical on the Notitia Galliarum, taken from a Manuſcript in the Abbey of St. Bertin, by Dom Anselme Berthod: *Methodized and augmented after his Death, by the* Abbe' Ghesquiere.

IN the collection of MSS. in the abbey of St. Bertin, there is a large one entitled *Decreta & Canones*, which is the work of Iſidore. To this is prefixed a *Notitia Imperii Romani*, or account of the provinces of the Roman empire, in which the ſtate of the Gallic provinces is more peculiarly deſcribed, ſo that it may be ranged among the different *Notitiæ Galliarum.* Upon this, as well as upon ſome of the other Notitiæ, the writer makes a variety of remarks, which we ſhall paſs over, as probably unintereſting to our readers. The account of Gallic provinces and cities copied from this MS. is given at the end, with all the variations of Father Sirmond's Notitia.

Memoir on the Goddeſs Nehallennia. By the Marquis du Chasteler.

ON occaſion of preſenting the Academy with a monument of this goddeſs found in Zeeland, this ſhort memoir was written. The monuments of Nehallennia were diſcovered in Zeeland in 1647. The temple in which they were contained appears to have been ſubmerged between the years 268 and 273 of Chriſt, when the tyrant Tetricus reigned here, medals of whom were found in it, but none later. The monument here figured is a kind of ſhrine, with a female figure ſitting, having a baſket of fruit on her lap, and another by her ſide, and a dog ſitting near. On a tablet below is inſcribed Deae. Nehallenniae. F. Calvisius. Secundinus. Ob. Meliores. Act. V. S. The etymology of the Goddeſs's name is by this writer ſuppoſed to be Celtic, in which language *Neal* or *Neach* ſignifies *high*, or *prime*, and *lenn*, water, whence he ſuppoſes it equivalent to *Goddeſs of the ſea, or waters.* The act. he interprets to be *actas* or *ſhores.*

A Diſſertation on the Inventions of the Belgians. By P. J. Heylen, *Dean of Lyre.*

THE writer divides his matter into three periods; the firſt comprizing the ages before the fall of the Roman empire; the ſecond, from thence to the birth of the emperor Charles V; the third, from that time to the preſent.

The Belgic inventions of the firſt period can only be derived from the ſlight incidental mention of ancient writers. Thus Pliny ſpeaks of horſe-hair ſieves, and the tinning of brazen veſſels, as invented by the Gauls. The Belgic chariots named Eſſeda and Covinus are alluded to by the poets. The Gauls made a kind of ſoap of ſuet and aſhes for reddening their hair. The Menapian hams or gammons of bacon were as famous anciently as thoſe of Weſtphalia at preſent. Belgic manufactures of woollen and linen were well known in the Roman empire. The Menapii and Morini excelled in the preparation of ſea-ſalt. The Belgians, according to Pliny, tempered ſaws ſo as to cut ſtone like wood.

During the ſecond period, the people of Liege began to work coal mines, of which the firſt notice is in 1189. The Dutch, and the people of Staveren in Frieſeland, are ſaid to have been the firſt mariners who paſſed the Sound, in 1089. Martin Behaim, a Fleming, is reported to have diſcovered the Azores before the Portugueſe, and even to have paſſed the Straits of Magellan. The mention of theſe, leads the author to all the other maritime diſcoveries of the Dutch and Belgians, though belonging to a later period; as thoſe of Barentz and Heemſkerk in the Arctic ſeas, of Father Hennepin in North America, of Taſman and Diemen in the South ſeas, of Sebald de Weert about the Magellanic regions, of Le Maire and Schouten further ſouthwards, and in the Pacific ocean, &c.

The fiſhing of herrings on the Engliſh and Scotch coaſts, was granted to the Dutch by Edward I. in 1295. The art of ſalting and pickling this fiſh, was diſcovered by William Beukels, a native of Biervliet in Flanders.

The art of painting in oil was till lately univerſally attributed to John Van Eyk, a native of Maeſeyk, who firſt mixed colours with linſeed and walnut oil, in 1410. But Heſſing, a German writer, has found in Theophilus, who lived in the eleventh century, a paſſage plainly mentioning the mixture of all kinds of colours with oil, for the purpoſe of painting wood work. Our author, however, contends, that Theophilus had no other idea than that of colouring over in oil, doors, windows, and other objects expoſed to the weather, in order to make the colour durable. It is certain that Cimabue, the reſtorer of painting in Italy, in the thirteenth century, knew nothing of the art.

Encauſtic painting on glaſs, though not invented by the Belgians, was carried by them to the height of perfection.

The invention of printing cannot by any good arguments be attributed to Coſter of Haarlem; yet many of the earlieſt books were printed in Holland and Flanders.

The art of cutting diamonds has been ſaid to be invented at Bruges, but without ſufficient authority.

The art of making tapeſtry was brought from the Levant after the cruſades, but attained its firſt perfection in the different towns of Flanders, as Arras, Bruges, Bruſſels, &c.

The firſt burſe or exchange for merchants was conſtructed at Bruges. 1. That of Antwerp was begun in 1633, and was afterwards imitated in the exchange of London.

Muſical chimes of bells are ſaid by L. Guicciardini to have been invented in Belgia, though he does not name the particular inventor. Ringing changes is reported to have been firſt in uſe at Aloſt in 1487. To this day, there are more ſets of chimes in the Low countries, than any where elſe.

The amuſement of ſkaiting on the ice, ſeems to be of Belgic origin, and was well known before the age of Charles V.

Of the Belgian inventions of later times, the writer firſt notices warlike machines. The people of Boiſleduc in the ſiege of a fortreſs called Poderoy in 1508 made uſe of a kind of mortar. Hand granades and bombs were uſed in the wars of the Low Countries, particularly the latter by Count Manſfeldt in the ſiege of Breda in 1625.

Of aſtronomical and geographical inventions, the univerſal aſtrolabe was deſcribed by Gemma Friſius, profeſſor at Louvain in the time of Charles V. Huygens diſcovered one of the ſatellites of Saturn in 1655. Mercator greatly improved the conſtruction of maps.

The

The obligations Anatomy lies under to Veſalius, Verheyen, and Ruyſch, are well known to thoſe verſed in that ſcience.

In Mechanics, Huygens firſt diſcovered the rules of the oſcillation of pendulums. Mills for pumping up water, and ſaw-mills were invented in Holland. Stevinus who made the famous ſailing chariot, was a native of Bruges. Bakker of Amſterdam invented the camel for raiſing ſhips in the water.

The teleſcope was invented in the United Provinces, but in what year, or by whom, is not certain. Some ſuppoſe it was at Middleburg in Zeeland, by accident, in 1590.

The microſcope was alſo a Dutch invention, by ſome given to Corn. Drebbel in 1621, who certainly was the inventor of the thermometer.

In Electricity, the diſcovery of the Leyden phial was made by accident in 1746, and related by Muſchenbroeck and Allamant.

The writer had forgot among the earlier inventions, to mention that of thread lace, for which Flanders has long been ſo famous.

Hiſtorical and Critical Memoirs or Enquiries to ſerve for the Hiſtory of Herman of Saxony, Count of Thuringia, firſt Huſband of Richilda, Counteſs of Hainault and Valenciennes.—By Mr. De Hesdin.

AS the ſubject of this elaborate paper, which is incapable of abridgment, is of merely local importance, it can ſcarcely intereſt any of our readers. We ſhall only obſerve, that contrary to the opinion of the Abbé Smet, who obtained the Academy's prize for their hiſtorical queſtion concerning the title of this Herman as Count of Hainault; this writer derives the lineage of Herman from *Baldwin IV.* or *the bearded*, Count of Flanders, whom he makes his maternal grandfather.

Enquiries concerning the Monies ſtruck in the Provinces of the Low Countries, with the Name and Arms of the Dukes of the Houſe of Burgundy, Counts of Flanders.

THESE Counts are four in number; Philip the Bold, John the Fearleſs, Philip the Good, and Charles the Raſh; whoſe united reigns comprize the period from 1384 to 1477. The monies of the firſt of theſe only are treated of in this paper, the greateſt part of which conſiſts of extracts from his edicts.

Deſcription of an Entertainment at Tournay in 1391, *with a Notice of the MSS. from which this Deſcription is taken. By Mr.* Gerard.

THE ſubject of this is a funeral after the rules of ancient chivalry, deſcribed in old French of the writing of the 15th century. The deceaſed was a gentleman of family, named Gerard de Mortaigne, but of whom nothing particular is known. The MS. containing the account is a book entitled *Le Droits d'Armes de Nobleſſe*, written by one Jaques de Valere.

All the remainder of this Volume conſiſts of *Notices of Manuſcripts and Monuments relative to Belgic Hiſtory.* They are as follow. A liſt of Manuſcripts in the Imperial library at Vienna; A notice of the Cartulary of Simon, a MS. in the library of St. Bertin;——A notice of ſome MSS. in the Abbey of St. Peter, at Ghent;——A notice of a MS. deſcribing the ordonnance of a banquet at Lille, held by Philip Duke of Burgundy in 1453, where was made the *Vow of the Pheaſant*;——A notice of ſome MSS. in the public library of Bern.

Tranſactions of the Royal Society of Edinburgh. Vol. I. 4to.

THIS work commences with a *Hiſtory of the Society*. The *Medical Society* of Edinburgh, inſtituted in 1731, was new modeled in 1739, ſo as to comprehend philoſophical and literary ſubjects. This *Philoſophical Society*, after having languiſhed for ſome years, was reſtored to vigour chiefly by the exertions of Lord Kaimes about 1777, and thenceforth its buſineſs was carried on with regularity and ſpirit. In the end of 1782, a ſcheme was propoſed by Dr. Robertſon for eſtabliſhing a new Society on a more extenſive plan, and incorporated by royal charter. This was carried into execution, and a charter was obtained from his Majeſty, dated March 29, 1783. The firſt meeting of the *Royal Society* was held on June 23d. of the ſame year, at which all the members of the former Philoſophical Society were aſſumed as members of this new one, and invitations to a ſelect number of diſtinguiſhed gentlemen were agreed upon. A conſtitution for the Society was eſtabliſhed, and laws and regulations were framed for its future proceedings. Of theſe, one of the moſt important to it as a learned body, was its diviſion into two claſſes, the *Phyſical* and *Literary*; the former having in its department, Mathematics, Natural Philoſophy, Natural Hiſtory, Chemiſtry, Medicine, and whatever relates to Arts and Manufactures;—the latter, Literature, Philology, Hiſtory, Antiquities, and Speculative Philoſophy. Theſe claſſes have their own preſidents and ſecretaries, and meet at ſeparate times: and the printed papers of the ſociety are arranged according to this diſtribution.

It is unneceſſary to follow particularly the ſubſequent *Hiſtory of the Society*, which conſiſts of a brief account of the papers read in each claſs, biographical memoirs of deceaſed members, and liſts of donations and aſſociates.

The Papers abridged in the Hiſtory are the following:

Experiments on Antimony. By Mr. JAMES RUSSELL.

THE object of theſe experiments was to find an eaſy and a cheap method of obtaining a ſolution of regulus of antimony in the muriatic acid, with a view to the preparation of tartar emetic, according to the directions in the laſt edition of the Diſpenſatory of the Royal College of Phyſicians in Edinburgh; the uſe of butter of antimony, as there directed, implying a very tedious, complicated, and expenſive proceſs. Mr. RUSSELL endeavoured to obtain pure dephlogiſticated muriatic acid in a fluid form, by adding to it the black calx of mangane ſe, (freed from particles of iron by digeſtion with vitriolic acid, and afterwards calcined by heat,) and then diſtilling it: But he found it impoſſible to condenſe the fumes of the muriatic acid when thus dephlogiſticated, (as it appeared to be by the black calx of manganeſe becoming white,) though he uſed a very long-necked retort, and had the receiver, containing water, immerſed in ſnow; for this acid, contrary to what happens to all the others, becomes much more volatile on being dephlogiſticated.

He then tried the effect of the vapours of this dephlogiſticated muriatic acid on regulus of antimony placed in the receiver and in the neck of the retort. This ſucceeded to his wiſh; the regulus diſſolving quickly and copiouſly. As regulus of antimony is an expenſive preparation, he made a trial of crude antimony inſtead of it; and he found that the muriatic vapours very ſoon diſſolved the metallic parts of it, and at laſt began to decompoſe the ſulphur, as, on trial, he found they did pure flowers of ſulphur. This he judged to be of little conſequence to the ultimate object, as the affinity of the muriatic acid to antimony is much ſtronger than that of the vitriolic. From a retort with ſome manganeſe in it, he diſtilled five ounces of muriatic acid on two ounces of crude antimony, moiſtened with water, raiſing the heat towards the end of the proceſs, to make the ſand pot red hot. After the proceſs, there were found in the receiver ſome ſulphur, ſome undecompoſed antimony, and a complete ſolution of the metal in the muriatic acid. This ſolution had all the properties of butter of antimony; and its precipitate, either by means of water or alkaliſ, was exactly ſimilar to the common one. Some tartar emetic, prepared from it, appeared, as to all its chemical properties, to be without fault; but Mr. Russell had not tried it medicinally. The quantity of precipitate, obtained from five ounces of acid and two of antimony, was about half an ounce. This muſt be perfectly free from all mixture of a mercurial ſalt or corroſive ſublimate, which, it has been ſuſpected, may be found in the common preparation. It may likewiſe be obtained with much more eaſe, and at leſs than a tenth part of the expence.

Obſervations on the ripening and filling of Corn. By Dr. Roebuck.

SUMMER 1782 having been remarkably cold and unfavourable, the harveſt was very late, and much of the grain, eſpecially oats, was green even in October. In the beginning of October, the cold was ſo great, that, in one night, there was produced on ponds near Kinneil, in the neighbourhood of Borrowſtounneſs, ice three quarters of an inch thick. It was apprehended by many farmers, that ſuch a degree of cold would effectually prevent the further filling and ripening of their corn. In order to aſcertain this point, Dr. Roebuck ſelected ſeveral ſtalks of oats, of nearly equal fulneſs, and immediately cut thoſe which, on the moſt attentive compariſon, appeared the beſt, and marked the others, but allowed them to remain in the field fourteen days longer; at the end of which time, they too were cut, and kept in a dry room for ten days. The grains of each parcel were then weighed; when eleven of the grains which had been left ſtanding in the field, were found to be equal in weight to thirty of the grains which had been cut a fortnight ſooner, though even the beſt of the grains were far from being ripe. During that fortnight, (*viz.* from October. 7 to October 21.) the average heat, according to Fahrenheit's thermometer, which was obſerved every day at eight o'clock in the morning and ſix in the evening, was a little above 43. Dr. Roebuck obſerves, that this ripening and filling of corn in ſo low a temperature, ſhould be the leſs ſurpriſing to us, when we reflect, that ſeed-corn will vegetate in the ſame degree of heat; and he draws an important inference from his obſervations, *viz.* That farmers ſhould be cautious of cutting down their unripe corn, on the ſuppoſition, that, in a cold autumn, it could fill no more.

A New Method of purifying Sea Salt. By the Earl of DUNDONALD's.

THE Earl of DUNDONALD's proceſs for purifying ſea-ſalt proceeded upon this obſervation, That the common ſea-ſalt poſſeſſes a conſiderable mixture of ingredients, which render it, in a great degree, unfit for preſerving victuals. Theſe ingredients appear, by experiment, to be nauſeous, bitter and cathartic ſalts, having an earthy baſis, (magneſia ſalita and magneſia vitriolata or Epſom ſalt) which are intimately mixed with the proper ſea-ſalt.

To purify common ſalt, by diſſolving it in water, decompounding the bitter ſalts, and precipitating their earthy baſis, by adding a fixed alkali, whether foſſil or vegetable, is a tedious proceſs, and by far too expenſive to be employed for œconomical or mercantile purpoſes. It is even imperfect; as it is almoſt impoſſible, after that proceſs, to ſeparate from the ſea-ſalt the Glauber ſalt, or vitriolated tartar, or ſalt of Sylvius, which are produced according as the foſſil or vegetable alkali is uſed.

Lord DUNDONALD obſerved, That hot water ſaturated with ſea-ſalt, will ſtill diſſolve a great part of the bitter earthy ſalts. His method, therefore, of purifying the common ſalt from theſe bitter ſalts is, To take a conical veſſel, having a hole in the ſmall end of it, which is to be undermoſt; to place it, filled with common ſalt, in a moderate heat; to take one twentieth part of the ſalt contained in it, and putting it in an iron pan, to diſſolve it in its proper proportion of water, ſo that the water ſhall be completely ſaturated with the ſalt; and then to pour this ſolution boiling hot on the ſalt in the conical veſſel, which is to be purified. The boiling water being already ſaturated with ſea-ſalt, will diſſolve no more of it, but will diſſolve much of the bitter earthy ſalts; and this ſolution will gradually drop out at the hole in the bottom of the cone. When it ceaſes to drop, the ſame proceſs is to be repeated by means of freſh portions of the ſame parcel of ſalt, already partly purified, till it be brought to the required degree of purity. Lord DUNDONALD reckons, that three ſuch waſhings make the common ſalt of this country purer than any foreign ſalt; that each waſhing makes it 4½ times purer than before; ſo that (diſregarding fractions) after the ſecond waſhing it will be 20 times, after the third 91 times, after the fourth 410 times, and after the fifth 1845 times purer than at firſt.

The ſuperiority of ſalt thus purified to common ſalt, is equally obvious to the taſte, and by its effect in preſerving fiſh, fleſh and butter; for it hath been often and carefully tried. Lord DUNDONALD conceives, that the ſimplicity, facility and cheapneſs of this method of purifying ſalt ſhould recommend it to common practice, as it is an object of great public importance. He adds, that as all ſalt made by boiling has a portion of uncombined magneſia mixed with it, it is proper to add a little muriatic acid to the firſt brine poured on the ſalt, in order to diſſolve the magneſia, and carry it off.

Dr. Walker read a letter from the Earl of Dundonald, giving an account of ſome further experiments on the purification of ſea-ſalt, which his Lordſhip communicated in compliance with the requeſt of the Society, at their meeting in February. The ſubſtance of the Earl's obſervations will beſt appear from the following table. Each portion of ſalt was purified by four waſhings, according to the method formerly deſcribed.

T A B L E.

	Salt employed.			Purified Salt.			Magneſia ſalita. Magn. vitriol.			
	lb.	oz.		lb.	oz.		lb.	oz.		
Salt hot from the pan firſt drawn,	56	00	contained of	49	00	and of	6	05	which is equal nearly to	$\frac{1}{9}$ of ſalt employed.
Salt hot from the pan laſt drawn,	56	00		33	09		22	06		$\frac{2}{5}$ Ditto.
Medium of the above,	56	00		41	04		14	05		$\frac{1}{4}$ Ditto.
Salt 6 weeks old,	56	00		47	00		7	00		$\frac{1}{8}$ Ditto.
Salt firſt drawn, dripped 24 hours,	56	00		52	12		3	00		$\frac{1}{18}$ Ditto.
Salt laſt drawn, dripped 24 hours,	56	00		44	08		11	00		$\frac{1}{5}$ Ditto.
Medium of the two laſt.	56	00		48	10		7	00		$\frac{1}{8}$ Ditto.
Spaniſh great Salt,	10	00		9	15½		00	00½		$\frac{1}{640}$ Ditto.
Baſket fine Salt,	3	00		3	00		00	00		

On the Engliſh Genitive. By Dr. Anderson.

Dr. Anderson is of opinion, that the Engliſh noun admits of no inflection by caſes, and therefore that the term *genitive caſe* is improper. He contends that the addition of the letter *s* with an apoſtrophe, to a noun, as *John*'s *ſtaff*, is not an inflection of the noun, and therefore cannot be termed a caſe. He affirms that when a noun undergoes a change of this ſort, it ceaſes to be itſelf a noun, and becomes immediately a definitive; the office of which is to limit and render more preciſe the general meaning of another noun, with which it is neceſſarily connected. Thus the general word *ſtaff* has its meaning limited, by the prefixing of the definitive *John*'s. He further obſerves, however, that all Engliſh nouns do not admit of this converſion into definitives. The names of animated beings, or corporeal objects, he conſiders as readily ſuſceptible of ſuch a change; but ſuch nouns as ſignify abſtract ideas, as *holineſs, diligence, whiteneſs*, he conſiders as incapable of being thus convertible into definitives. He concludes, by recommending to grammarians, as an object worthy of inveſtigation, the aſcertaining the difference betwixt ſuch definitives and adjectives, to which they bear a near reſemblance.

On the Œconomical Uſes to which Caſt Iron may be applied. By the Same.

HE obſerved, That, in ſeveral mechanic arts, maſſes of great weight, ſize and ſtrength, are required for bruiſing or grinding various ſubſtances; that it is often difficult to procure ſtones of ſufficient ſize and ſtrength for theſe purpoſes; that caſt iron, though proper in point of ſtrength, and eaſily made of almoſt any ſize or ſhape, is ſometimes inconvenient from its weight, and is, for many purpoſes, too expenſive. He propoſed, therefore, that, inſtead of pure iron, the moulds in which ſuch maſſes are to be caſt ſhould be nearly filled with ſtones, or what would be ſtill better, with bricks, as theſe could be eaſily moulded into the exact ſhape required; a proper ſpace being left for an axle where needed, and an interſtice between the outermoſt of them and the mould; that then melted iron ſhould be poured in to fill up ever chink. This iron, cooling and conſolidating, will unite or cement the ſtones or bricks firmly together, and cover them with an uniform ſurface of metal. Thus, Dr. ANDERSON thinks, that maſſes of any ſize, ſhape and weight, and of ſufficient ſtrength, may be procured at a cheap rate; as a very ſmall quantity of metal would be ſufficient for a cement and coating to the ſtones or bricks.

In the ſame way, the Doctor thinks many architectural ornaments might be made very cheap and very durable; and he ſuggeſts the application of this method to the important purpoſe of bridge-building, where very large ſtones are often required for the conſtruction of arches. Inſtead of ſuch large ſtones, he propoſes to uſe compound maſſes, ſuch as thoſe above deſcribed, cemented with iron, and exactly moulded, ſo as to form, if required, an entire rib of an arch without a fiſſure; and he thinks that, in this way, a number of arches might be accurately and firmly put together.

Caſe of an Obſtinate Singultus. By Dr. ANDREW DUNCAN.

A Gentleman, in the 73d year of his age, was ſeized with a violent hiccough, which continued without intermiſſion for ſeveral hours. Dr. DUNCAN preſcribed for him a mixture containing a drachm of *acidum vitriolicum tenue*, united with four ounces of mint-water, of which a table-ſpoonful was to be taken every half hour. The firſt doſe put a ſtop to the *ſingultus*. About twelve hours afterwards, there was a return of the fit; which, however, yielded inſtantly to a ſecond ſpoonful of the mixture; nor was there afterwards any occaſion to repeat the doſe.

Aſtronomical Obſervations. By Mr. P. WILSON.*

ABOUT the year 1767 or 1768, Mr. WILSON entertained an opinion that the aberration of the fixed ſtars indicated the proportion between the orbital velocity of the earth, and the velocity of light in the vitreous humour of the eye. This opinion ſoon led him into various diſcuſſions, and, in particular, made him ſuppoſe, that the aberration of the fixed ſtars, when determined by obſervations made with a teleſcope filled with water, would be different from the aberration determined by obſervations made with a common teleſcope. Mr. Wilson has given an account of ſome important and unexpected conſequences reſulting from theſe ſpeculations, in the Philoſophical Tranſactions of London. About the year 1775 or 1776, Mr. Wilson began to entertain an opinion that the center of the ſolar ſyſtem was in motion, and in 1777, communicated to Mr. Robison, and others, a paper on this ſubject. The water-teleſcope was, by this time, become familiar to his thoughts; and it occurred to him, that it might be employed for deciding this queſtion, and even for determining the direction and velocity of this motion; by means of the difference between the obſerved aberration of the fixed ſtars and the aberration which ſhould reſult from the earth's orbital motion alone. But various objections and difficulties occurred in the proſecution of this attempt, and Mr. Wilson ſoon after thought of another method.

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* [Mr. JOHN ROBISON, General Secretary, informed the Society, that, a few days ago, Mr. JAMES RUSSELL, one of the members, had offered to him the peruſal of a paper, written by a friend, and containing ſome thoughts on a method for diſcovering by obſervation, whether the center of the Solar Syſtem was in motion; with other intereſting matters in aſtronomy. Mr. ROBISON, recollecting that Mr.

If the earth be carried, with a great velocity, towards a fixed ſtar, whoſe rays are made to deviate a little by an achromatic priſm, it will follow, that a conſtant angle of incidence will give different angles of total deviation, according to the velocity of the motion; and this difference will be both real and apparent. Therefore,

1. Let the teleſcope of a meridional quadrant be furniſhed with a priſm, refracting a few degrees in altitude. Search, by meridional obſervations, for ſuch ſtars as exhibit altitudes inconſiſtent with Dr. Bradly's aberrations: The differences will indicate an aberration cauſed by a motion of the earth, different from its orbital motion round the ſun.

2. Furniſh a teleſcope with a plain mirror, inclined to its axis in an angle of 45°, and a ſeries of achromatic priſms refracting 90°. Suppoſe the teleſcope to be directed to a point of the heavens, 90° diſtant from a ſtar which is viewed through it. Suppoſe alſo the earth to be at reſt, and the images of this ſtar, formed by the refracted and by the reflected light, to coincide. Then ſuppoſe the earth to be in motion towards this ſtar: The images will ſeparate, both on account of a change in the total deviation of the refracted light, and alſo on account of a tranſverſe aberration, to which the refracted image is liable, by the motion of the teleſcope.

3. If a long achromatic teleſcope be directed to a fixed ſtar, towards which the earth is moving, the focal diſtance of the teleſcope will be lengthened. The augmentation will indeed be very ſmall, but Mr. Wilson has fallen upon very ingenious methods of increaſing it, ſo as to make it become ſenſible.

Account

Mr. Patrick Wilson, aſſiſtant Profeſſor of Aſtronomy at Glaſgow, had long ago communicated to him in converſation, ſome curious ſpeculations on this ſubject, told Mr. Russell, that, before peruſing his friend's paper, be would write an account of what he could recollect of Mr. Wilson's ſpeculation on that ſubject. This account he now laid before the Society, in order to aſcertain the title to originality or priority, in any thing which may have occurred to both of theſe gentlemen.

Account of a Hurricane at Barbadoes, October 10, 1780. *By Dr.* BLANE.

BARBADOES had not been viſited by a hurricane for more than a century. When on the 9th of October 1780, it began to blow hard, and on the 10th the wind roſe to a prodigious degree of violence, about eight o'clock it began to tear off the roofs, and overthrow the walls of houſes, it was at its height about midnight, and did not abate till eight the next morning. The ravage made was dreadful, the inhabitants were driven from their houſes, and obliged to paſs the night expoſed to the wind, the cold, and an inceſſant torrent of rain, multitudes periſhed from various accidents to the amount of more than 3000.

Bodies of men and cattle were lifted from the ground and carried ſeveral yards, the fruits were deſtroyed, trees torn from their roots or ſtripped of their bark, many houſes levelled with the ground, and the church of Bridgetown reduced to a heap of ruins. The ſea roſe ſo as to deſtroy the fort, and carry the guns from the platform. Ships were driven on ſhore, the Mole-head was ſwept away, and ridges of coral rock were thrown up above the ſurface of the water, ſhells and fiſh were thrown on ſhore, of ſpecies hitherto unknown. But the harbour and road have been improved, and the anchoring ground cleared of a cruſt of coral.

The ſhips moſtly put to ſea, where many of them periſhed. Of twelve king's ſhips, five were loſt, and not more than ten or twelve men ſaved.

Many circumſtances tend to prove that an earthquake attended it, the paving of the church, and caſks in a cellar were removed, rocks were rent, and chaſms remained in the earth. This earthquake was felt both at St. Lucia and Barbadoes.

The hurricane chiefly affected Barbadoes, Martinique, St. Lucia and St. Vincent's; Antigua, St. Chriſtopher's, the Virgin iſlands, and Grenada but ſlightly. How far it extended eaſt and weſt is unknown. At St. Vincent's and St Lucia, it was thirteen or fourteen hours later than at Barbadoes. At St. Domingo they had it in a trifling degree on the 13th and 14th.

Much lightning attended the hurricane; at St. Lucia there was much of what the French call *feu de St. Elme*, which Dr. BLANE ſuppoſes to be the *ignis fatuus*. An Aurora Borealis appeared in the N. E. an unuſual appearance in the Weſt Indies. A rumbling noiſe was heard in the ſky, the wind was remarkably cold.

The influence of the hurricane on the health of the people was remarkable. Inſtead of producing ſickneſs, it ſeemed to have the very oppoſite effect. There was leſs ſickneſs after, than there had been before it; and moſt of thoſe who were ſick at the time, were benefited by it, except the very old and delicate, who ſuffered, either from mechanical violence, or the ſubſequent want of ſhelter. It had a viſible good effect on the diſeaſes of the climate, fevers and fluxes. Chronic diarrhœas, the conſequence of dyſenteries, were alſo cured by it. But the diſeaſes on which it operated moſt viſibly and ſenſibly were pulmonic complaints. Some recent caſes of phthiſis, and even the acute ſtate of pleuriſy, were cured by it. Nay, in the more advanced and incurable ſtate of the phthiſis, the hectic fever was, in a great meaſure, removed, and a temporary alleviation at leaſt procured. Dr. BLANE mentioned particularly the caſe of a lady of his acquaintance, who was ill of a pleuriſy at the time of the hurricane, and paſſed more than ten hours in the open air, ſitting generally in a plaſh of water from the rain that fell; ſhe had no more of her complaint, nor any return of it; and Dr. Blane ſaw her a few weeks after in better looks and in a better general ſtate of health than ſhe had enjoyed for a great while before. It was a general obſervation, that people had remarkable keen appetites for ſome days after the hurricane; and many people, who uſed to be thin and ſallow, Dr. Blane ſaw looking freſh and plump a few weeks after it, though the unhealthy rainy ſeaſon was there hardly over. Theſe facts, which appear ſo very wonderful, Dr. Blane mentions with confidence, they being confirmed by a concurrence of teſtimony, and, in ſome meaſure, by his own obſervation.

Account of William Lothian, D. D. By Mr. Dalzel.

WILLIAM LOTHIAN, D. D. ſenior miniſter of Canongate, was born in Edinburgh, November 5, 1740. He had his academical education in the College of Edinburgh, where he was diſtinguiſhed for diligence and promiſing talents, and was admitted in many of the ſocieties then formed by the ſtudents in that univerſity, to improve themſelves in various parts of knowledge.

He was licenſed to preach the Goſpel in October 1762, and ordained miniſter of Canongate in 1764. As a preacher, his method of inſtruction was ſimple and perſpicuous, his ſentiments rational and manly; his manner unaffected and perſuaſive. Although afflicted for many years with a painful diſeaſe, he found leiſure to write the Hiſtory of the United Provinces of the Netherlands, part of which work he publiſhed in 1780, previous to which publication, the Univerſity of Edinburgh had conferred on him the degree of doctor in divinity.

In his laſt illneſs his patience and fortitude never forſook him. He expired December 17, 1783. He married his couſin Elizabeth Lothian, by whom he has left four ſons and a daughter. The doctor was one of the firſt members of this ſociety. He alſo publiſhed two ſermons, to be found in the ſecond volume of the *Scotch Preacher*, printed at Edinburgh in 1776.

Account of Sir George Clerk-Maxwell, Baronet. By Mr. John Clerk, *Jun.*

SIR George Clerk-Maxwell of Pennycuik, was born in Edinburgh the 31ſt of October 1715, being the fourth ſon of Sir John Clerk, one of the barons of the Exchequer in Scotland, by a daughter of Sir James Ingliſh of Cramond: he ſtudied at the Univerſity of Edinburgh, and very early caught a ſtrong taſte for Natural Hiſtory, Antiquities and the Theory of Commerce. From thence he went to Leyden, and ſtudied under Boerhaave, before his return he viſited France and Germany.

On his return he applied himſelf to the ſtudy of the commercial intereſt of Scotland, eſtabliſhed a Linen Manufactory at Dumfries, and ſet on foot ſome projects for working lead and copper mines. In 1755 he addreſſed two letters to the Truſtees for Fiſheries, &c. on the common mode of treating wool, and ſuggeſting a more judicious ſcheme which has been univerſally practiſed. In 1761 he wrote a paper on the advantages of ſhallow plowing.

In 1741 he was appointed lord Treaſurer's Remembrancer, a commiſſioner of the forfeited eſtates in 1752, a truſtee for Fiſheries, &c. in 1760, and in 1763 a commiſſioner of the Cuſtoms. The two Boards of Truſtees often committed affairs to his ſole management, which he executed to their ſatisfaction. By his advice the ſovereignty of the Iſle of Man was purchaſed of the duke of Athol, and the ſmuggling trade checked.

Mr. Clerk was ſkilful in Natural Hiſtory, Mineralogy, Geography, Engineering, and Drawing. In 1745 he ſerved in the Yorkſhire Hunters. He was one of the chief promoters of the drawing ſchool in the Univerſity of Edinburgh. He married when young, his couſin Dorothy Clerk-Maxwell, of Middlebie in Dumfries-ſhire, by whom he had ſix ſons and ſeven daughters, of whom two of each ſurvived him. In 1783 he ſucceeded his elder brother Sir James Clerk, in the the title of baronet. He ſuffered many ſhocks in the laſt years of his life by the deaths of his children, and acute bodily pains waſted his conſtitution. He died January 29, 1784.

Account of Matthew Stewart, D. D. By Mr. JOHN PLAYFAIR.

HE was the ſon of the Reverend Dugald Stewart, Miniſter of Rothſay, in the Iſle of Bute, and born in the year 1717. Having finiſhed his courſe at the grammar-ſchool, he was entered in 1734 at the Univerſity of Glaſgow, where he was diſtinguiſhed by the friendſhip of Dr. Hutcheſon and Dr. Simſon, the latter of whom was engaged perfecting what had been begun in Mathematics, by Fermat, Halley and others. Under him and Mr. Maclaurin, when Mr. Stewart removed to Edinburgh, he made a great progreſs. In 1746 Mr. Stewart publiſhed his *General Theorems.* Prior to which he had entered into the church, and had attained the living of Roſeneath. The publication of his *General Theorems* given before the vacancy of the profeſſorſhip of Mathematics at Edinburgh, ſecured to him the election of that office. Soon after he gave the world a ſolution of Kepler's problem which was publiſhed in the Eſſays of the Philoſophical Society of Edinburgh for 1756.

In 1761 he produced the *Tracts Phyſical and Mathematical.* A few months after he gave the world another work entitled, *Propoſitiones Geometricæ More Veterum Demonſtratæ.* Several propoſitions which appear in Dr. Simſon's writings were the production of Dr. Stewart, and remain to mark the friendſhip of thoſe two Mathematicians.

Dr. Stewart's health beginning to decline, he retired into the country in 1772, where he ſpent the greateſt part of his life, and in 1775 his ſon was elected joint profeſſor with him, and gave an early ſpecimen of his abilities. After this he continued to make his favourite ſtudy his amuſement, until nearly the time of his death, which happened January 23, 1785, at the age of 65.

PAPERS OF THE PHYSICAL CLASS.

I. *Experiments on the Motion of the Sap of Trees.* By JOHN WALKER, *D. D. M. D. F. R. S. Edin. and Regius Prof. of Nat. Hiſtory in the Univerſity of Edinburgh.*

THE doctrine of the circulation of the ſap in vegetables, after having engaged the attention of eminent philoſophers for above a century, yet remaining undetermined by experiment, Dr. Walker inſtituted an experimental enquiry with a view to the following purpoſes: "To know whether all the parts of a tree bleed at once, or by ſucceſſion: How far the aſcent and diffuſion of the ſap depends on the temperature of the air: To trace the route which it obſerves, and to obtain ſatisfaction concerning what is called its *recidivation*, and in ſeveral other particulars relative to its movement."

The ſubject of the experiment was a young birch tree; and the firſt obſervations were taken from a number of triangular inciſions, a foot above each other, made on the north ſide of the trunk of the tree, in the month of March. They were an inch long on each ſide, and the ſame in depth, penetrating through the bark, into the wood. The time at which each of theſe came to bleed is accurately noted, with the daily ſtate of the thermometer. Other inciſions were afterwards made on branches, and the appearances attending them are likewiſe noted. Corollaries and particular obſervations are occaſionally drawn from the facts reſulting from theſe experiments. Theſe are not capable of abridgment; but the following are the general concluſions deduced from the whole.

The bleeding ſap begins firſt to flow at the root, to aſcend ſlowly upwards, and to bleed ſucceſſively as it aſcends, to the very extremities of the tree. In the year theſe experiments were made, it aſcended twenty feet from March 11th. to April 22d. viz. 43 days; in another year it roſe to the ſame height in the ſame tree in 33 days. From theſe variations in the riſing of the ſap is to be aſcribed the difference in the time of vernation in different years.

During the bleeding ſeaſon, the whole ſap of the tree is in a progreſſive ſtate upwards; though liable to fall back or run out in any direction on inciſion.

In none of the experiments could any ſap be perceived to ariſe either by the pith or bark. It roſe either by the wood, or between the wood and the bark. It moves both in the ſubſtance of the ligneous circles, and in the veins by which they are ſeparated; more expeditiouſly in the latter. It riſes more freely in young than in old circles; of courſe, in the exterior than the interior part of a trunk or branch.

The *cauſe* of the aſcent of the ſap is ſtill involved in obſcurity. Heat, indeed, appears to be the prime agent; as, with a few exceptions, the aſcent was conſtantly promoted by warmth, and retarded or ſtopped by cold. But the exact manner in which theſe effects are produced does not appear.

From the preceding experiments, the fact, that the terminating buds of branches firſt diſcloſe themſelves in the ſpring, ſeems to be owing to their being placed on the youngeſt wood, where they receive the moſt copious flow of ſap.

The Linnean theory, that the pith is neceſſary, not to the vegetation of the plant, but to the formation of the ſeeds, is confirmed by theſe experiments, no ſap having been at any time obſerved either to aſcend or deſcend by the pith. The nouriſhment of the pith appears to be derived from the wood alone.

The

Fig 1

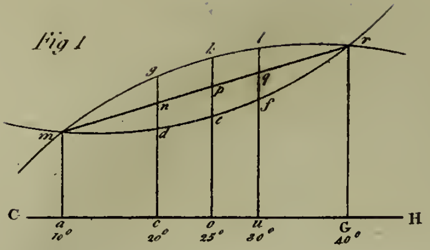


Fig 2

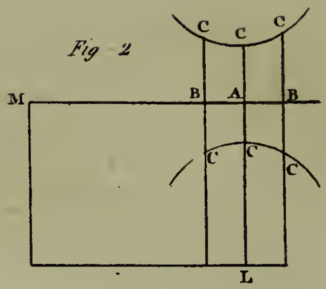


Fig 3

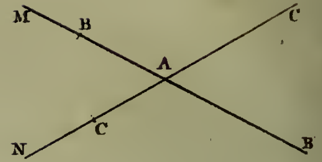


Fig 4

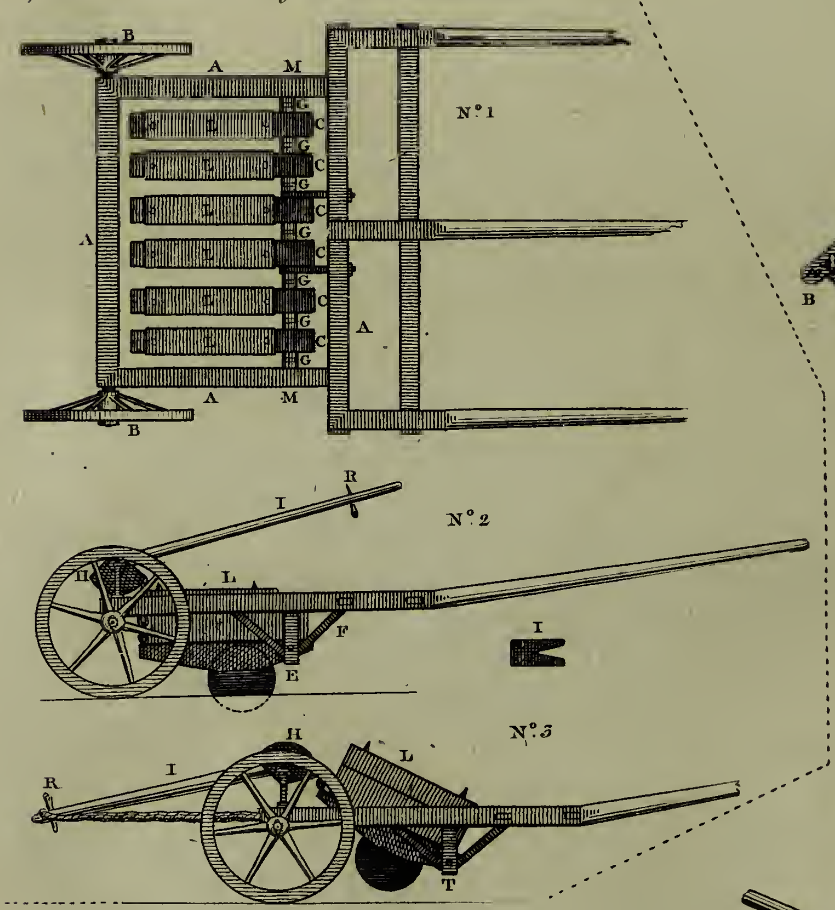


Fig 11

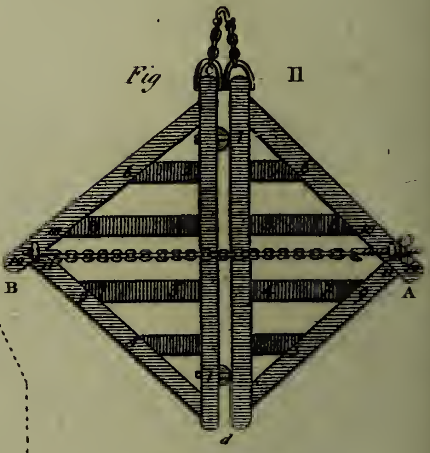


Fig 3

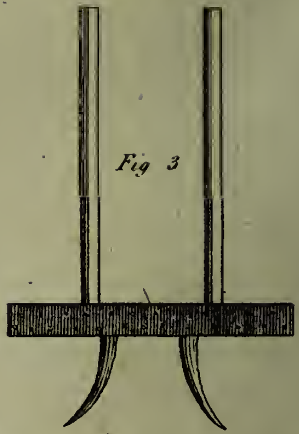


Fig 4

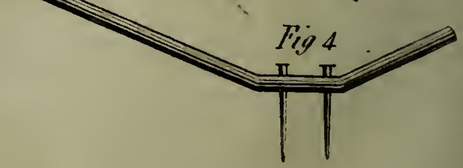


Fig 5

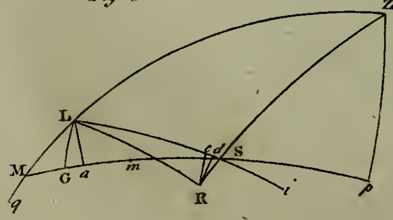
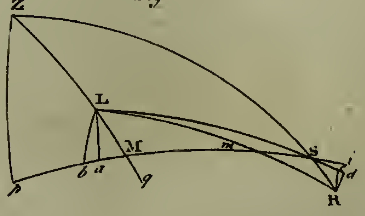


Fig 6



The experiments prove that there is no *circulation* of the ſap during the bleeding ſeaſon, but that, as Hales thought, its aſcent is uniform. It is poſſible, however, that while the tree is in leaf, the ſap may take a different courſe. But the determination of this point requires a further ſet of experiments.

II. *The Theory of Rain.* *By* JAMES HUTTON, *M. D. F. R. S. &c.*

PART I.

Inveſtigation of the Law of Nature, on which is to be founded a Theory of Rain.

THE ſubject of this paper is to inveſtigate the rule directing the action and effects of heat and cold, and to form from thence a theory for rain on the evaporation and condenſation of water. The breath of animals becomes viſible in a cold atmoſphere, and tranſparent ſteam becomes miſt in air of a colder temperature. To account for theſe effects, the air inſpired is to be conſidered as a menſtruum diſſolving water on the lungs, and becoming ſaturated in that degree of heat. The ſolution being cooled, the water ſeparated from the menſtruum becomes viſible. So water may by means of heat be rendered an elaſtic fluid, which being condenſed the water appears. But this appearance is not the effect of the general principles of heat and cold: to explain it the knowledge of a particular law is required, and it is to be obſerved, that the effects of heat and cold in relation to air and vapour are not uniform.

The diſſolving power of air on water may vary in different proportions to the heat. The ſolution may vary as the heat, or in a greater or leſs ratio: that is the increments of each may be conſtant, or thoſe of the heat being conſtant, the increments of the ſolution may be accelerated or retarded.

This may be repreſented geometrically. (Plate X. Fig. 1.) Let $C\,H$ repreſent the ſcale of the thermometer, $a\,m$, $b\,r$, perpendicular ordinates, the quantity of water held in ſolution by a given quantity of air of the temperatures a and b. Join $m\,r$ and draw the curves $m\,g\,r$, $m\,d\,r$. Then it is evident that the ordinates to $m\,r$ mark a ſolution varying as the heat; the ordinates to $m\,d\,r$, a ſolution varying in a greater ratio, and to $m\,g\,r$ in a leſs ratio than the heat.

The ordinates to the line $m\,r$, drawn from a point, denoting the temperature of the mixture, repreſent the quantity of water contained, (diſſolved or not) in an unit of the mixture, for the ordinates $m\,a$, $r\,b$, are as the quantities contained in a unit of air of the temperatures a and b, and as upon mixture the heat and water are uniformly diſſolved, they vary in the ſame proportion, and may be expreſſed by the ſame meaſure.

Suppoſing equable ſolution, mix equal portions of ſaturated air, temperatures 10 and 40, the mixture of temperature 25 is repreſented by $o\,p$, which alſo repreſents the quantity of water in an unit of the mixture, and the quantity of water held in ſolution by an unit of air of temperature 25.

So two portions of temperature 40, being mixed with one of temperature 10, the temperature produced 30, will be expreſſed by $w\,q$.

In the curve mdr, let equal portions of the ſolution in 40 and 10 be mixed, then op is the quantity of water contained in this mixture, at the mean heat 25, whilſt oe is the ordinate of ſolution, conſequently ep is the quantity of water that cannot be retained in ſolution, in this medium temperature produced by the mixture.

In the curve mgr, let equal portions in 40 and 10 be mixed, and the ordinate being drawn in the medium degree of heat 25, ok will be the whole power of ſolution, n the quantity of water that air is capable of diſſolving in this degree of heat, but op being the quantity of water actually in the mixture, the air is underſaturated with humidity, by the quantity pk.

Thus, the actual curve of evaporation being known, the effect of any mixture of two portions of different temperatures may be aſcertained. If the ſolution of water in air increaſes equally with the heat, there will be neither ſuper nor underſaturation in a mixture of portions of different degrees of heat. If this ſolution increaſes with heat, but in a decreaſing rate, there will be underſaturation. If it increaſes with heat in an increaſing rate, there will be ſuperſaturation.

The laſt caſe applies to the phænomena of breath and ſteam rendered viſible in mixing with air colder than themſelves, and to various appearances, that may occur in mixing together ſeveral portions of air, differently ſaturated with humidity, and in different temperatures. For it is not every mixture of atmoſpherical fluid in different temperatures, that forms a viſible condenſation, this effect depending on the degree of ſaturation with humidity. But if two portions of the atmoſphere both ſaturated with humidity ſhould be mixed, let there be but a difference in their temperatures, a condenſation proportionate to this difference will take place.

This rule of condenſation may be applied to the theory of rain, which is the diſtillation of water firſt diſſolved in the atmoſphere, and then condenſed from that ſtate of ſolution. Water is indeed condenſed in a cloud, and clouds may ſubſiſt without rain: but, without condenſation of acqueous vapour in the atmoſphere, no rain can be produced.

A convincing proof of this is given by M. de Maupertuis, who, in his *Diſcours ſur la méſure de la terre*, ſays, that at Tornea, upon the opening of a door, the external air immediately converts the warm vapour of the chamber into ſnow, which then appears in what he calls "de gros tourbillons blancs." So at Peterſburgh in 1773 a gentleman broke a window in a crouded aſſembly, to relieve the company ſuffering from the cloſeneſs of the room, and the cold air ruſhing in, formed a viſible circumgiration of a ſnowy ſubſtance.

The wiſe ſyſtem of nature could not be carried on without this particular law of aqueous condenſation. By the circulation of the fluid atmoſphere the heat of torrid regions is carried away, and the cold of frigid regions temperates the exceſſive heat on the earth's ſurface in ſummer. And thus, by tranſporting the heat and cold of diſtant regions, the parts of the earth moſt diſtant from the ſea may be ſupplied with ſhowers of rain at every ſeaſon of the year; but if the mixing together of the atmoſpherical ſtreams produced no condenſation, in the ſummer the earth would be parched with drought, and in the winter deluged with rain.

At preſent from the influence of the aſcending ſun, two oppoſite currents of air are formed in the ſummer hemiſphere, one moving along the ſurface of the earth from the pole to the equator, the other flowing above in an oppoſite direction. Theſe oppoſite currents whilſt ſeparate might paſs each other without producing rain, but when ſufficient portions are mixed, not only clouds but ſhowers will be produced, ſince the ſudden formation of a mean degree of heat, in the mixture of two portions of different temperatures, muſt condenſe a quantity of vapour ſufficient to form rain.

Without this law of condenſation of evaporation, neither rain nor dew could take place any where in the ſummer hemiſphere, perhaps not even in the tropical latitudes: there would be evaporation and a general tendency to ſaturate the atmoſphere with water, but the mixture of different portions of air would only temper the ſaturation without producing a condenſation of vapour in the mean degrees of heat. At night, from the influence of the cold, the atmoſphere would become gradually clouded: this cloudineſs would increaſe to a general diſtillation of condenſed vapour, which would be uniformly continued, until the returning ſummer ſhould change the ſtate of condenſation to evaporation. And inſtead of the beautiful return of ſeaſons, tempered with various degrees of heat and refreſhing ſhowers, ſix months rain and ſix months drought would follow each other in an invariable ſucceſſion.

PART. II.

The Theory of Rain applied to natural Appearances.

1. *On the generality of rain.*

SUPPOSING the earth to be wholly covered with water, the ſun to be ſtationary in the equator, and the earth immoveable, there would be a circulation in the atmoſphere from the dark to the illuminated, and from the heated to the place of greateſt cold. There would be two regions of extreme heat and cold, and between them one of temperate heat and continual rain.

Suppoſing the earth to turn round its axis, the torrid region would become a zone, and be temperate compared with its former ſtate, and there would be perhaps alternately condenſations and evaporations of the atmoſphere. From this zone we might paſs through another ſubject to continual rain, till we arrive at a point of great cold and congelation.

Were this aqueous globe to be moved round the ſun with a certain inclination of its axis, heat and cold muſt be alternately produced in every part of it, by which would be produced either annual ſeaſons of rain, or diurnal ſeaſons of condenſation and evaporation, or both theſe ſeaſons in ſome degree.

In this globe the effects would be conſtant, and the ſeaſons fixed and determinate. The irregular ſurface of our globe muſt evidently produce different effects: the fluid atmoſphere is effected with the heat of each part of the ſurface, with which it comes in contact; and the ſeveral parts of this elaſtic fluid, whether ſaturated or not with aqueous vapour, will be ſubject to the utmoſt irregularity of mixture.

Hence over the whole globe, there will be occaſionally rain and evaporation more or leſs. Wind and rain will be variable, in proportion as each place is ſituated in an irregular mixture of land and water: wind is regular in proportion to the uniformity of the ſurface, and rain in proportion to the regular changes of thoſe winds, by which the mixture of air neceſſary for rain is produced. Thus our theory agrees with the facts in nature.

2. *Of*

2. *Of the regularities of rain.*

In the Indian ſea there are periodical trade winds: theſe ſtreams of atmoſphere muſt produce ſomewhere a mixture of different portions of the fluid maſs, and, if rain is the conſequence, we muſt conclude, that thoſe mixed portions of the air have been ſufficiently ſaturated with moiſture, and in different temperatures. This is actually the caſe, there are regular appearances of rain, which correſpond to the regular cauſes now aſſigned.

According to our theory, there ſhould be in the iſlands under the line in the middle of the Indian ocean, periodical condenſations correſponding to the diurnal influence of the ſun, and nocturnal motions in the atmoſphere. It is ſo in fact. Sea and land breezes are felt there regularly every day, and in the diurnal commotions of the atmoſphere, there will be frequently portions of it, ſufficiently ſaturated with vapour, and mixed in different degrees of heat.

But the great annual rains on the tropical continent of Aſia and Africa, illuſtrate ſtill better this explanation. The rains are in the ſeaſon of the ſummer ſolſtice, and fair weather is produced by the removal of the heating cauſe. The place of the air, elevated by the heat of the ſun at this ſeaſon, is ſupplied with other air ſaturated with moiſture from the neighbouring ſeas: this air, being alſo elevated, muſt be either tranſported from thence towards the polar regions, or fall down in rain. It is evident that the former ſuppoſition does not take place, for then there would be no rain, but this air in its elevation mixes with thoſe portions, which have loſt their heat to a ſufficient degree, that the commixture may produce a condenſation of water.

Suppoſing the continent not to have as in the tropical parts of Aſia and Africa a ſufficient ſupply of water, the ſummer's ſun will produce drought rather than rain, except when tranſient ſtreams of air, proper for the purpoſe, occaſion ſhowers of great importance to vegetation, but not to be conſidered as a general ſeaſon for rain. On the decline of the ſummer, the atmoſphere becomes diſpoſed to produce rain with every mixture of a different temperature. And hence the autumnal rains and winter ſnows, which fall with all the regularity of the tropical rains.

3. *Of apparent exceptions from the generality of rain.*

It is no exception to the theory laid down, that in a few places there is no rain, as there may be ſome local cauſes which produce this variation from the general rule. The lower Egypt, and a narrow ſpot on the coaſt of Peru, are the only inſtances of this ſingular occurrence. With reſpect to the latter, we might conclude, from Ulloa's obſervations on the ſteadineſs of the wind blowing on the coaſt of Peru, that there would be either continual rain or no rain at all. In the laſt caſe the vapours from the ſea might be carried over the coaſt, to be condenſed by mixing with other ſtreams of cold atmoſphere in the Andes, where it rains abundantly for moſt part of the year.

Since there are but two places without rain on the earth, we are not on that account to ſet aſide the general rule, but preſume, that there are wanting certain conditions requiſite to condenſe humidity in the air. The cauſe of rain, though often exerted, will not produce always the full effect; a ſcanty condenſation of aqueous vapour produces miſts on the earth, and clouds in the atmoſphere above. And in taking the gradation from one extreme of tranſparent atmoſphere to the other of the denſeſt cloud, from the falling of the gentleſt miſt to the heavieſt rain, hail and ſnow, we have an indefinite variety of appearances, all flowing from one ſimple principle.

4. *Comparative eſtimate of climates in relation to rain.*

In eſtimating the quantity of rain in different climates, the two principles on which it depends muſt always be kept in view. 1ſt. There muſt be a meeting of different ſtreams of air in proper degrees of heat, and therefore the mixture of winds and their temperature muſt be conſidered. 2d. The quantity of rain depends, *cæteris paribus*, on the quantity of humidity contained in theſe ſtreams of air.

From the irregularity of the earth's ſurface, the mountains, woods, and barren deſarts, a great variety will take place in reſpect of the action of theſe two principles. Mountains will break the ſtreams of air, and to that and not to any attraction muſt we attribute the greater quantity of rain and thunder in mountainous countries, than in the plains. There will be alſo more rain on land than on the ſea, for the latter being plane has not the power of varying the direction, and mixing together the ſtreams of air.

As far as the principle of humidity is concerned, the greateſt quantity of rain ſhould fall, *cæteris paribus*, on land contiguous to a great ſea in a tropical ſituation, and the leaſt quantity in the moſt inland part of Europe and Aſia, in a temperate latitude. The firſt poſition is proved by a fact, that in the Eaſt Indies 104 inches of rain have fallen in one place in a ſeaſon, at leaſt three times the quantity falling in the temperate latitudes. Not having any meteorological regiſter with reſpect to the ſecond poſition, we muſt determine it from other facts. The Caſpian ſea and the lakes in North America lie nearly in the ſame latitudes, and conſequently there ſhould be, *cæteris paribus*, an equal evaporation from equal ſurfaces. The water received by the Caſpian ſea is all evaporated, but to the lakes, there is a conſiderable outlet, and as the Caſpian ſea receives its water from a much greater portion of land than the lakes, there ought according to this rule to be no outlet to the latter. But as there is an outlet, we muſt couclude, that much more rain falls in North America, than on a ſimilar ſituation in Europe and Aſia. Still it may be alledged, that the evaporation from the lakes may be leſs than that from the Caſpian, and conſequently there might be a redundancy of water without the ſuppoſed greater portion of rain. But from whence could this greater evaporation proceed? The cold is much greater on the lakes than by the Caſpian ſea, and this cold ariſes from the ſame cauſe which produces the greater quantity of rain.

5. *The theory applied to meteorological obſervations.*

In meteorological obſervations, three things are to be conſidered. 1. The quarter from whence the wind comes. 2. The degree of heat in the atmoſphere indicated by the thermometer. 3. The weight of the atmoſphere indicated by the barometer.

In conſidering the quarter from whence the wind comes, we are liable to many deceptions. For as the direction of the wind on a particular ſpot is no proof, that that direction has been the ſame for a great diſtance, we may confound a ſouth wind with one coming directly from the weſt, and miſtake a north for a weſterly wind. Hence the direction of the wind at a given place in an iſland like ours, is to be corrected by its temperature; as there is reaſon to conclude, that the thermometer is in this reſpect a better guide than the local appearance.

Thermometrical obſervations are variable. A certain allowance is in general to be made for the diurnal influence of the ſun. Nothing changes ſo much the temperature of the atmoſphere, as a change in the direction of the wind. A ſouthern atmoſphere tranſported over this iſland, muſt produce a heat above the mean temperature of the ſeaſon, and a northern atmoſphere muſt produce the contrary effect. An eaſtern or a weſtern atmoſphere, may not neceſſarily produce any change in the place of obſervation. And hence we may obſerve the propriety of the general rule, for determining the region from whence the atmoſpherical ſtream proceeded, viz. that we are to aſcribe more to the heat and cold of the fluid compared with our mean temperature for the ſeaſon, than to the direction in which the ſtream paſſes over our heads.

The barometer is a juſt meaſure of the weight of our atmoſphere. From certain changes in it, connected with a diſpoſition to rain, philoſophers have improperly concluded, that the rarity of the atmoſphere is an immediate cauſe of rain. The neceſſary conſequence of rain is to make the atmoſphere lighter, by the quantity of water ſeparated from the air; but as the quantity of rain fallen bears no proportion to the quantity of loſt preſſure, indicated by the barometer, the appearance of the barometer cannot be conſidered as the cauſe or the effect of rain. In fact, theſe changes in the barometer are not confined to the place, where there is a change of weather; at the diſtance of 400 miles and perhaps much more, two barometers riſe and fall nearly in the ſame manner, though it is frequently rainy weather at one place, while it is fair at the other.

The change in the weight of the atmoſphere is the conſequence of ſome great emotion in that fluid body, and different parts being conſequently mixed, there is a probable cauſe for the production of rain. But it does not appear, why the fall of the barometer ſhould, any more than its ſudden riſe, be a neceſſary indication of rain; though we may account for the indication of a continuance of fair weather on the gradual riſe of the barometer. For ſuppoſing fair weather and an undiſturbed atmoſphere in this quarter of the earth, the neceſſary evaporation from the ſurface muſt gradually increaſe the weight of the atmoſphere, and the barometer muſt riſe with a gradual progreſs.

The barometer is ſubject to greater changes in the temperate, than in the torrid regions. For the ſtate of the atmoſphere of the latter, bounded on each ſide by temperate regions, cannot be ſo affected, as that of one liable to change from the extremes of heat and cold on its oppoſite ſides. Beſides, the change from heat to cold, depending on the ſun, is much the greateſt in the temperate regions.

The barometer is neceſſarily connected with motions in the atmoſphere, but not equally affected by every motion. It is affected only by thoſe, which produce accumulation and abſtraction of the fluid. And as every commotion of the atmoſphere may under certain conditions be a cauſe for rain, the barometer, though of greater uſe in determining heights, may be made of importance in meteorological obſervations.

Within the tropicks, though the variation of the barometer is ſmall, there are greater falls of rain than in the temperate zones. But in the former ſituation, where the atmoſphere is ſaturated with vapour and of great heat, a ſmall quantity of air of different temperature is required; and the converſe is true in the temperate regions.

Thus there will be greater temporary accumulations and abſtractions of atmoſphere, and conſequently greater changes of the barometer in the latter, than in the former ſituation.

Thus natural appearances confirm our theory, which eſtabliſhes for the immediate cauſe of rain, the mixture of ſeveral portions of atmoſphere in different temperatures of heat. We may now conſider the natural appearances which attend rain in this iſland.

1. According to our theory, calmneſs or ſteady breezes are the attendants of fair weather, and the converſe is equally true. People indeed, who reaſon from obſervation alone, attribute wind to the ſhower as an effect, whereas it is a cauſe.

2. When rain begins in calm weather, wind may be expected, and a calm follows rain that begins in windy weather, on this principle, that wind is the cauſe of rain, and in the oppoſition of winds, a calm is produced.

3. During a calm and clear ſky, ſhowers never happen, with ſqualls of wind ſudden ſhowers appear. In calm weather before rain the heaven is overclouded, and the rain is general; when attended with wind, it is unſteady. Theſe facts neceſſarily imply a mixture of hot and cold ſtreams of air for the production of rain.

4. Sometimes the operation is viſible; clouds are ſeen moving in oppoſite directions, and experienced ſeamen have obſerved, that this oppoſition, or as it is termed the clouds going againſt the wind, is a ſure ſign of a heavy rain.

5. The changes of the temperature of our atmoſphere attend the alterations of rain and fair weather. A wind from the ſouth replete with humidity, brings warm weather, if rain ſucceeds, it is followed by a change of wind, and the air becomes colder. If a north wind prevails, and is ſucceeded by rain, there is a change of wind and temperature of the air.

It is common on the coaſt of Hudſon's bay, for a ſtorm to come on from the north weſt, attended with ſnow and hail, when the thermometer is at 90° and the ſky perfectly ſerene. It ſoon clears up, but the temperature of the air is changed; from 90° the thermometer falls to 50° for a ſhort time, and then gradually riſes. This points out the agitation of the air as the cauſe, and not the conſequence of rain. Not that agitation alone is the cauſe of rain, there muſt be in the mixed atmoſphere alſo a ſaturation of humidity ſufficient to co-operate with it.

6. Rain happens in all weathers, from the greateſt degree of heat down to the freezing point. In a ſettled froſt, when it begins to ſnow, the thermomer riſes, when the ſnow has fallen the ſky becomes clear and the cold increaſes.

7. The climate of our iſland is (according to a fanciful expreſſion of the profeſſors) temperance in extreme. The winds are very variable, and conſequently from the mixture of different ſtreams, there muſt be a great condenſation of aqueous vapours. The quantity of rain, falling in a year, is not a ſufficient teſtimony of the prevalence of this condenſation, as without rain there may be a great condenſation of aqueous vapour. A known fact, that for one day or hour of ſunſhine, there are two or three of cloudineſs, determines the queſtion.

8. To inveſtigate the effect of this aqueous condenſation in our atmoſphere on heat and cold, we are to conſider, that it may be produced by a mixture of air either hotter or colder than our atmoſphere, whoſe temperature will be brought to a greater or leſs degree of heat, according to the nature of the ſupervening air producing cloudineſs. If the heat of the atmoſphere is above the mean temperature for the

ſeaſon, and there is a change from a ſerene ſky to cloudineſs, the atmoſphere will be cooled, and *vice verſa.*

A clear ſky is perfectly conſiſtent with the extremes of heat and cold. It is the mixture of hot and cold atmoſphere, which produces cloudineſs. Hence the common obſervation is explained, that the air is always cold or below its mean temperature for the ſeaſon, when the ſky is clear. The country people call it froſty, though in the middle of ſummer, and probably find hoar-froſt in the morning in the higher parts of the country, and the making of ice in Bengal juſtifies this obſervation.

9. Hail and ſnow formed on the ſame principles are equally explained by this theory. Hail is evidently formed by the collection of molecules of the nature of ſnow, by means probably of electrical attraction.

10. Thunder, a phænomenon often attending rain, deſerves conſideration. But from our ignorance of the principles, on which electricity is the cauſe of condenſing vapour in the atmoſphere, we can only conclude, conſiſtently, with appearances, that there is, in the caſe of thunder with violent rain, a more ſudden attraction of the condenſed particles of water, than what happens upon other occaſions.

III. *Mr. Playfair's Remarks on the Cauſes which affect the Accuracy of Barometrical Meaſurements, which follows here in the Edin. Tranſactions, admitting of very little Abridgment, we ſhall, in order to do Juſtice to ſo valuable a Paper, inſert it in our Appendix at the End of the Volume.*

IV. *On the Uſe of Negative Quantities in the Solution of Problems, by Algebraick Equations.*

By William Greenfield, *M. A. &c.*

THE introduction of negative roots is attributed to Albert Girard, whoſe work, entitled, *Invention nouvelle en Algebra,* was publiſhed in 1629, whereas the Geometry of Des Cartes, to whom Montucla aſcribes this invention, was not publiſhed till 1637. Des Cartes indeed, not aware of the advantage to be derived from the uſe of negative quantities, obſerves only that the ſhifting of a line or point from one ſide of a given line or point to the other, makes no difference, except of the ſigns + and — in the equation.

The uſe of negative quantities was not for ſome time familiar to mathematicians. In the *Elementa Curvarum* of John de Witt, publiſhed by Schooten, at the end of his edition of Des Cartes' Geometry, no notice is taken of negative abſciſſæ and ordinates, and in the four equations belonging to ſtraight lines, 1. $y = \frac{bx}{a}$; 2. $y = \frac{bx}{a} + c$. 3. $y = \frac{bx}{a} - c$. 4. $y = -\frac{bx}{a} + c$, he no where ſhews that each of theſe equations by changing the ſigns of y or x, gives the relation of the abſciſs and ordinate, when one or other is taken in an oppoſite ſituation.

The notions of Dr. Wallis on this ſubject were not perfectly clear. For in his Arithmetic of infinites, he did not ſee that his general expreſſion for hyperbolic areas, by having a negative denominator, expreſſed the area on the other ſide of the ordinate, but ſays only, that when the denominator was leſs than nothing, the area was more than infinite. Dr. Halley was ſurprized, that his formula by the change of ſigns gave the focus of converging or diverging rays, whether reflected or refracted by ſpecula or lenſes. And Mr. Molyneux ſpeaks of the univerſality of this formula, as ſomewhat reſembling magic.

The imperfect knowledge of the theory, on which the uſe of theſe negative quantities is grounded, prevented theſe mathematicians from applying them ſo frequently as at preſent, and the myſterious accounts of them often given by writers of the greateſt eminence, ſhew, that if the certainty of the application is not doubted, a good explanation of them is to be deſired. Baron Maſeres, in his large work on the uſe of the negative ſign in algebra, is for the diſcarding of them entirely, but as they free us from much inconvenience, that would otherwiſe be unavoidable in the analyſis of curves, it is to be lamented, that he did not exert his induſtry rather in demonſtrating, how far we might rely on the method of negative quantities, than in overturning ſo great a part of the labour of modern algebraiſts. The following is an attempt to ſet this ſubject in a clearer light.

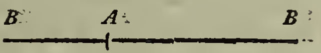
I. *Of the Negative Roots of Equations.*

1. *Of determinate Equations.*

Suppoſing one quantity only to be determined in an equation, it may be reduced to this form,

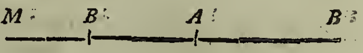
$$L \ldots\ldots a + bx + cx^2 + \&c. = 0.$$

Where the ſign + denotes the addition or ſubſtraction of the terms at pleaſure. In many caſes the magnitude of the quantity alone is to be determined by the poſitive roots, of which if there are none, or none coming within the limits of the problem, the problem is impoſſible. But, beſides the magnitude, the poſition of the roots with reſpect to the point A, may be required, and the only difference in theſe equations is the circumſtance of the opoſite ſituations of AB.



To determine the magnitude of AB on the right ſide, the poſitive roots in the equation L are to be employed.

On the other ſide of A let $MA = +$ not leſs than any negative root of L, which may then be reduced to this form



$$M \ldots \left\{ \begin{array}{l} \quad A \\ + \; BX + Bx \\ + \; CX^2 + 2\,CXx + Cx^2 \\ \qquad\qquad + \&c. \end{array} \right\} = 0.$$

And again to this form

$$N \ldots\ldots A + B\,(X + x) + C\,(X + x)^2 + \&c. = 0.$$

Another expreſſion of the conditions required of x, when it lies to the right of A.

If it lies to the left of A, that being the only alteration in the conditions required of x, the equation will become

$$N' \ldots A + B\,(X - x) + C\,(X - x)^2 + \&c. - = 0.$$

And it may be reduced to this form

$$M' \ldots \left\{ \begin{array}{l} \quad A \\ + BX - Bx \\ + CX^2 - 2CXx + CX^2 \\ \qquad\qquad + \&c. \end{array} \right\} = 0.$$

And by comparing it with M and L to this form,

$$'L \ldots a - bx + cx^2 - \&c. = 0.$$

The poſitive roots of $'L$ determine the different magnitudes of AB, when to the left of A, and L' differs from L only, by having changed the ſigns involving the odd powers of x. They have therefore the ſame roots, except that the poſitive of one are the negative of the other. The negative roots of L are the poſitive roots of the equation, to which it would be reduced by ſuppoſing AB to the left of A, and therefore theſe negative roots are the determinations of AB in this laſt ſituation.

This mode of reaſoning applies to problems in general, whether involving relations of time, of force, of value of ſtock, where the time may be before or after a given period, the force acting in a certain or a contrary direction, the ſtock may be real or part of debts.

The negative roots are uſeful in problems relating to abſtract quantities. For $L \ldots a + bx + cx^2 - = 0$, has the ſame roots as $'L \ldots a - bx + cx^2 - \&c. = 0$, except that the negative of the one are the poſitive of the other. In any problem therefore producing an equation L, ſuch that $'L$ may be conſidered as a different caſe of it, the negative roots are uſeful by giving from either equation the ſolution of both caſes. Thus from $x^2 + x = a$ we have one root, which added and another which ſubſtracted from the ſquare, equals the given quantity.

2. *Of indeterminate Equations.*

Let $AB = x$ and $AC = y$, and let it be required now to determine not only the magnitudes of theſe lines, but their poſition with reſpect to A or the line MB. If AB lies to the right and BC above AB, we uſe this equation, (ſee Plate X, Fig. 2).

$$L \ldots a + bx + cy + dx^2 + exy + fy^2 \;\&c. = 0.$$

And the poſitive roots are to be employed.

Take MA on the other ſide $= X$, not leſs than any negative value of x, and AL below $MB = Y$, not leſs than any negative value of y, L may be reduced to this form

$$M \ldots \left\{ \begin{array}{l} \quad A \\ + BX \;\; + BX \\ + CY \;\; + \;\ldots + Cy \\ + DX^2 + 2DXx + \;\ldots + Dx \\ + EXY + EYx \;\; + EXy \;\; + \ldots + Exy \\ + FY^2 + \;\ldots + 2FYy + \ldots + \ldots + Fy^2 \\ \qquad\qquad\qquad\qquad + \&c. \end{array} \right\} = 0.$$

Which may be reduced to this form

$$N \ldots A + B\,(X + x) + C\,(Y + y) + D\,(X + x)^2 + E\,(X + x)\,(Y + y) \\ + F\,(Y + y)^2 + \&c. = 0.$$

But if x lies to the right of A, when y lies below AB, in this new ſtate of the conditions, which N required of x and y, the equation will become

$$N' \ldots A + B\,(X + x) + C\,(Y - y) + D\,(X + x)^2 + E\,(X + x)\,(Y - y) + F\,(Y - y)^2 + \&c. = 0.$$

And being reduced to the form M, and compared with L, it is evidently the ſame as

$$L' \ldots a + bx - cy + dx^2 - cxy + fy^2 + \&c. = 0.$$

And the correſponding poſitive roots of $'L$ are the determinations of AB and BC, when x lies to the right of A and y below AB.

$'L$ differs from L only by having changed the ſigns of the odd powers of y. Therefore $'L$ and L have the ſame roots, except that the poſitive roots of the one are negative in the other, and in the equation L, the poſitive values of x and correſponding negative values of y are the determinations of AB and BC, when AB lies to the right of A and BC below AB; and in the ſame manner the negative values of x, and correſponding poſitive values of y, or the correſponding negative values of x and y, may be ſhewn to be the determinations of AB and BC, when AB lies to the left of A and BC above or below AB.

II. *Of the Negative Quantities which are not the Roots of Equation.*

The given quantities in problems are frequently conſidered as capable of exiſting in one or other of two oppoſite ſituations, which may be repreſented by addition and ſubtraction. Let $AB = a$ $AC = b$, be quantities in an equation capable of being taken to the right or left of A, and the equation may be repreſented by the form in Plate 10. Fig. 3.

$$L \ldots p + qa + rb + sa^2 + tab + vb^2 + \&c. = 0.$$

Take $AM = A$ and $AN = B$ not leſs than a, b reſpectively to the left of A, then the equation may be transformed into

$$M \ldots \left\{ \begin{array}{l} \quad P \\ + QA + Qa \\ + RB + \ldots + Rb \\ + SA^2 + 2SAa + \ldots + Sa^2 \\ + TAB + TBa + TAB + \ldots + Tab \\ + VB^2 + \ldots + 2VBb + \ldots + \ldots + Vb^2 \\ \qquad\qquad\qquad\qquad + \&c. \end{array} \right\} = 0.$$

And again reduced to this form

$$N \ldots P + Q\,(A+a) + R\,(B+b) + S\,(A+a)^2 + T\,(A+a)\,(B+b) + V\,(B+b)^2 + \&c. = 0.$$

In this equation AB and AC are to the right of A, and by reaſoning as before, when AB or AC is taken to the left, the equation will be the ſame with L, except that the quantity, which has changed its ſituation, will have changed its ſign.

Hence may be drawn the following concluſions.

1. Where the indeterminate quantity in a problem is capable of exiſting in two oppoſite ſituations to be repreſented by addition or ſubtraction, the equation, whoſe

poſitive roots give the value of x for one ſituation, will by its negative roots determine x in the oppoſite ſituation.

2. And when a given quantity a is capable of exiſting in two ſuch oppoſite ſituations, theſe ſituations will be determined by changing in the equation the ſign of the odd powers of a.

V. *Experiments and Obſervations upon a remarkable Cold which accompanies the Separation of Hoar-Froſt from a clear Air.* By Patrick Wilson, *M. A. F. R. S. Edin. and Profeſſor of Aſtronomy in the Univerſity of Glaſgow.*

MR. WILSON had made ſome experiments and obſervations upon Cold in the years 1780 and 81, which were publiſhed in the *Lond. Philoſ. Tranſact. Vol.* LXX. and LXXI. Theſe were principally relative to the fact, that the the temperature of the ſnow lying on the ſurface of the fields, was found conſtantly colder than that of the air a few feet above. His firſt conjecture reſpecting the cauſe of this phænomenon was, that it proceeded from the cold produced by the evaporation from the ſnow; but various circumſtances proving, that inſtead of evaporation from the ſurface of the ſnow, a depoſition of hoar-froſt from the air was taking place, this hypotheſis became untenable. Various ſurmiſes were ſuggeſted to his mind on this ſubject, which he determined again to put to the teſt of experiment. Accordingly, having got ready a ſet of very ſenſible thermometers conſtructed by his father, with *flattened bores*, he took the advantage of a ſevere froſt on December 28, 1783, to commence his operations.

Of the experiments and obſervations firſt detailed, the general reſult was, that the ſnow continued colder than the air four feet above it, only ſo long as it was attracting hoar-froſt at its ſurface; but that as ſoon as this attraction ceaſed (indicated by the change from a clear, to a foggy or cloudy ſky), and even when it was followed by a ſlow evaporation, the ſnow quickly became as warm or warmer than the air.

The experiments of the ſecond ſection, begun on Jan. 24, 1784, were meant to diſcover, whether an equal degree of cold would not be produced by the attraction of hoar-froſt from the air, by means of other ſubſtances of a looſe contexture. Trials made with ſand, powdered charcoal, braſs ſhavings, &c. proved an equal diſpoſition in them to attract hoar-froſt and produce cold, with that of ſnow. A large ſurface of quickſilver compared with an equal one of ſand, ſhowed leſs power in theſe reſpects. On the whole, Mr. Wilſon thinks himſelf warranted to lay down theſe *general concluſions*. "That, when bodies attract hoar-froſt from a clear air, there is a cold produced at their ſurfaces; and that this cold does not originate from any peculiar qualities of bodies upon which the hoar-froſt ſettles, any farther than as ſome bodies are capable of attracting from the air more or leſs of it in a given time:"

"That the diſpoſition of the air of thus parting with hoar-froſt, and the cold which accompanies that ſeparation, has a conſtant dependence upon the general ſerenity of the atmoſphere, and is always interrupted upon the ſky being overcaſt with clouds or fogginеſs, eſpecially near to the place of obſervation."

In ſect. 3. an obſervation is noticed the very reverſe of the former, in which an exceſs of cold at the ſurface of the ſnow took its riſe from evaporation. This happened, however, in particular circumſtances of weather; the air being only five degrees below freezing, the ſky clear, with a ſtrong north wind, and a very vivid Aurora Borealis. The dryneſs of this wind robbed every thing of its hoar-froſt, and therefore no cold could reſult from its depoſition. On the other hand, the ſnow evaporated very faſt, and occaſioned an exceſs of cold at its ſurface of 4, 5, or 6 degrees.

Some of the facts which occurred during the courſe of experiments, make it, in the author's opinion, probable, "that the extrication of hoar-froſt requires an action continued for ſome length of time, upon a given portion of air." But the eſtabliſhment of this propoſition, as well as the elucidation of other points belonging to the ſubject, would require an experimental enquiry directed to theſe peculiar purpoſes.

VI. *An Account of the Method of making a Wine, called by the Tartars Koumiſs; with Obſervations on its Uſe in Medicine. By* JOHN GRIEVE, *M. D. F. R. S. Edin. and late Phyſician to the Ruſſian Army.*

THOUGH various writers have taken notice of the liquor made by the Tartars from mare's-milk, yet, as Dr. Grieve obſerves, imperfect or erroneous notions of its nature have hitherto prevailed even among men of ſcience; and particularly it has been thought, that the ſaccharine ſubſtance contained in the *whey* was the ſole cauſe of the fermentiſcibility of milk. How far this is from being the caſe, will appear from the following genuine method of making *Koumiſs*, communicated to the writer by a Ruſſian nobleman, and ſucceſsfully uſed by himſelf.

"Take of freſh mare's milk of one day, any quantity; add to it a ſixth part of water, and pour the mixture into a wooden veſſel; uſe then, as a ferment, an eighth part of the soureſt cow's milk that can be got; but, at any future preparation, a ſmall portion of old *Koumiſs* will better anſwer the purpoſe of souring; cover the veſſel with a thick cloth, and ſet it in a place of moderate warmth; leave it at reſt twenty-four hours, at the end of which time, the milk will have become ſour, and a thick ſubſtance will be gathered on the top; then, with a ſtick, made at the lower end in the manner of a churnſtaff, beat it, till the thick ſubſtance above mentioned be blended intimately with the ſubjacent fluid. In this ſituation, leave it again at reſt for twenty-four hours more; after which pour it into a higher and narrower veſſel, reſembling a churn, where the agitation muſt be repeated, as before, till the liquor appears to be perfectly homogeneous; and in this ſtate, it is called *Koumiſs*; of which the taſte ought to be a pleaſant mixture of ſweet and ſour. Agitation muſt be employed every time before it is uſed." This proceſs is varied in different places by the degree of heat and agitation, and the kind of ferment uſed.

When this liquor is employed medicinally, it is given at pleaſure both as food and drink; and ſome caſes are here briefly related, in which it proved highly reſtorative in emaciation, hectic, nervous debility, and incipient phthiſis. From the ſucceſs in theſe, Dr. Grieve is induced to recommend it more generally as an antiſeptic, tonic,

and

and reſtorative. The paper concludes with ſome account of a method of bringing cow's milk into a ſtate of vinous fermentation, and obtaining from it a vinous ſpirit; extracted from a Diſſertation publiſhed by *Oſeretſkowſky*, who accompanied *Lepechin* and other academicians in their travels through Siberia and Tartary.

VII. *An Improvement of the Method of correcting the obſerved Diſtances of the Moon from the Sun or fixed Star.* *By the Rev.* THOMAS ELLIOT, *Miniſter of the Goſpel at Cavers.*

THE apparent altitudes are ſuppoſed given, and the differences between them and the true altitudes are found by the requiſite tables. The difference between the apparent and true altitude of the Moon, call the corrected parallax. Let the altitudes be ſuppoſed unequal, then,

To the logarithmic cotangent of half the ſum of the apparent altitudes add the logarithmic tangent of half their difference, and from the ſum ſubtract the logarithmic tangent of half the apparent diſtance, the remainder will be the logarithmic tangent of a 1ſt arc.

The ſum of arc 1ſt and half the apparent diſtance, will be a 2d arc.

The difference of arc 1ſt and half the apparent diſtance, will be a 3d arc.

To the log. tangent of arc 3d add the log. tangent of the greater altitude, the ſum, rejecting radius, will be the log. coſine, either of the angle itſelf at the higher object, between the other object and the zenith, or of its ſupplement to 180°, as arc 1ſt is leſs or greater than the half diſtance. As the application of the *firſt* and *third* corrections depends on the quality of the angles, it muſt be obſerved, that, if arc 1ſt is leſs than the half diſtance, the angle *itſelf* will be found, and will be acute; but if arc 1ſt is greater than the half diſtance, the angle found will be the *ſupplement* of the angle at the higher object to 180°, and the angle itſelf will be obtuſe, or greater than 90°. Neverthelefs, if the greater altitude is that of the Moon, the coſine thus found is to be uſed in computing the *firſt* correction of diſtance.

To the log. tangent of arc 2d add the log. tangent of the leſſer altitude, the ſum, rejecting radius, will be the log. coſine of the angle at the lower object, between the other object and the zenith, and will always be acute.

Theſe two angles being known, the ſeveral corrections of diſtance will be found as follows:

1. To the arithmetical complement of the log. coſine of the angle at the Moon, add the proportional logarithm of the corrected parallax, the ſum will be the proportional logarithm of the *firſt* correction, which is to be added to the apparent diſtance if the angle at the Moon is obtuſe, and ſubtracted if acute.

2. Add together the proportional logarithms of the ſum and difference of the corrected parallax and *firſt* correction of diſtance, and take their ſum, which, for diſtinction, call the rectangle logarithm. To the rectangle logarithm, add the conſtant logarithm 1.5819, and the log. tangent of the diſtance *once* corrected, the ſum of theſe three logarithms, rejecting ten from the index, will be the proportional logarithm of the *ſecond* correction of diſtance, which is always to be added, except the diſtance is more than 90°, in which caſe it is to be ſubtracted.

To half the rectangle logarithm add the log. ſine of the diſtance *twice* corrected, the ſum, rejecting ten from the index, will be the proportional logarithm of a correction, to be ſubtracted from the angle at the Star, or to be added to its ſupplement.

3. To the arithmetical complement of the log. coſine of the corrected angle at the Star, add the proportional logarithm of the Star's refraction, the ſum will be the proportional logarithm of the *third* correction, which (contrary to the *firſt*) is to be ſubtracted from the diſtance, if the angle at the Star is obtuſe, and added if acute.

Theſe three corrections, applied as above directed, will give the true diſtance of the Moon from the Sun or a fixed Star.

There is, indeed, a *ſecond* correction for the Star's refraction, ſimilar to the *ſecond* correction for parallax; but in moſt caſes it will not amount to $1''$; and even when the Star's altitude is only $5°$, and the diſtance only $20°$, it will not exceed $2''\frac{1}{2}$: It may, therefore, generally be omitted. But, if it is deſired, this correction may be found in the ſame manner as the *ſecond.*

4. Add together the proportional logarithms of the ſum and difference of the Star's refraction and *third* correction of diſtance, the conſtant logarithm 1.5819, and the log. tangent of the diſtance *thrice* corrected, the ſum of theſe four logarithms, rejecting ten from the index, will be the proportional logarithm of a *fourth* correction, which, added to the diſtance, thrice corrected, will give the true diſtance.

Another method to find the angles at the Moon and Star.

1. *At the Moon.*

Add together the apparent zenith diſtance of the Star, the apparent zenith diſtance of the Moon, and the apparent diſtance of the Star from the Moon's centre; take their ſum, half their ſum, and the difference between the half ſum and the zenith diſtance of the Star; then add together the arithmetical complements of the log. ſines of the Moon's zenith diſtance and the apparent diſtance of the objects, and the log. ſines of the half ſum, and the difference between the half ſum and the zenith diſtance of the Star. Half the ſum of theſe four logarithms will be the log. coſine of half the angle required, which being doubled, will give the angle at the Moon between the zenith and the Star.

2. *To find the angle at the Star.*

Add together the zenith diſtance of the Moon and Star, and the apparent diſtance, and take their ſum and half ſum as before; but now take the difference between the half ſum and the zenith diſtance of the Moon; then add together the arithmetical complements of the log. ſines of the Star's zenith diſtance and the diſtance of the objects, and the log. ſines of the half ſum and the difference between the half ſum and the zenith diſtance of the Moon. Half the ſum of theſe four logarithms will be the log. coſine of half the angle, which, being doubled, will give the angle at the Star between the zenith and the Moon.

In the ſpherical triangle MZS, let Z be the Zenith, M, S, apparent places of Moon and Star, let Zp be a vertical to MS, the apparent diſtance produced if neceſſary, biſect MS in m. Then (by caſe 11. obl. ſph. triary) pm will be the firſt arc. Half the baſe added to pm will be the ſecond arc, or QpM, and difference of pm and half the baſe or pS will be the third arc.

ZPM

ZpM and ZSp are right angled triangles. $\therefore$ $R. \times$ Cos. $ZMS =$ Tang. Alt. $\times$ Tang. MS in the ſame manner ZSM is found.

The parallax in altitude is found by the common proportion Rad: Cos. Alt : : Sine Hor. par: Sine par. in Alt.

Let $Lq =$ parallax in Altitude, $Mq =$ refraction, then $Lq - Mq = LM$ the corrected parallax, $SR =$ ſtar's refraction, then $LR =$ true diſtance of moon and ſtar. Draw La perpendicular to MS, and Rc to LS, and make Ld equal to LR and $Sb = SL$.

1ſt. correction Ma, diſtance once corrected Sa
2d. correction ab, diſtance twice corrected $Sb = SL$
3d. correction Sc, diſtance thrice corrected Lc.
4th. correction cd, diſtance four times corrected $Ld = LR$

$Ma = ML \times$ Cos. LMS, Rad. $= 1$.

$$ab = SL - Sa.\ \text{Tang.}\,\frac{LM + aM}{2} \times \text{Tang.}\,\frac{LM - aM}{2} = \text{Tang.}\,\frac{{}^2La}{2} \text{ and Tang.}\,\frac{SL + Sa}{2} \times \text{Tang.}\,\frac{SL - Sa}{2} = \text{Tang.}\,\frac{{}^2La}{2}.$$

Hence we have the tangent of $ab =$

$$2\ \text{Tang.}\,\frac{{}^2La}{2} \div \text{Tang.}\,\frac{SL + Sa}{2}$$

Since the corrected parallax can never exceed $56'\frac{1}{2}$, the arcs, ſines and tangents in triangle LMa may be taken indifferently for one another, and the operations will be much ſhortened.

The rectangle logarithm is the proportional logarithm of La^2, its half is the proportional logarithm of La, $\frac{La}{\text{Sine } LS} = LSA$, which being ſubſtracted from ZSM, leaves $ZSL = pSi$ or dSR. (See Plate X. Fig. 5, 6.)

The third correction $Sc = SR \times$ cos. cSR.

The fourth correction $cd = LR - Lc$ is found in the ſame manner as ab.

VIII. *Account of a Remarkable Agitation of the Waters of Loch Tay, in a Letter from the Reverend* Thomas Fleming, *Miniſter of Kenmore.*

ON Sunday the 12th of September 1784, about nine in the morning, an unuſual agitation was obſerved in *Loch Tay.* Near the village of Kenmore is a bay, the greater part of which is very ſhallow, and the reſt very deep, at the extremity of the bay the water was obſerved to retire above five yards within its ordinary boundary, and in about four or five minutes to return again. This was repeated three or four times within a quarter of an hour, when all at once the water ruſhed from the eaſt and weſt, in oppoſite currents acroſs the bay, and about the edge of the deep part roſe in the form of a great wave, leaving the bottom of the bay dry, to the diſtance of between 90 and 100 yards from its natural boundary. When the oppoſite currents met they made a claſhing noiſe, and the ſtrongeſt impulſe being from the eaſt, the wave rolled ſlowly weſtward, diminiſhing as it went for the ſpace of five minutes, when it wholly diſappeared. The water continued to ebb and flow in about the ſpace of ſeven minutes for two hours, when it ſettled into its ordinary level.

At the ſame time a river, north of the bay, was ſeen to run back, and its channel was left dry about twelve feet from either edge. Under a bridge the current failed and left the bed of the river dry, where there had been before eighteen inches of water. During the whole time the weather was calm, and both that and the preceding day the barometer ſtood at 29½ inches. For five ſucceeding days the ebbing and flowing continued, but not in the ſame degree, and a ſimilar agitation was remarked at intervals till the 15th of October, ſince which no ſuch thing has been obſerved. No motion of the earth was felt in the neighbourhood, or any agitation of the waters but near Kenmore.

IX. *Abſtract of a Regiſter of the Weather, kept at Branxholm for Ten Years, ending December* 31, 1783. *Communicated by the Duke of* BUCCLEUGH.

IN the regiſter from which this abſtract is taken, the numbers were marked every day at nine o'clock *A. M.* The quantity of rain was meaſured by means of a tin cylinder, guarded by a wooden box, and ſunk in the earth, into which the rain was received through a funnel, whereof the area was quadruple that of the cylinder. A gage, which floated on the ſurface of the water in the cylinder, had a rod fixed to it, divided into inches and tenths, which paſſed through the pipe of the funnel. The fourth part of the riſe of this index marked the depth of rain which had fallen ſince the laſt obſervation, and theſe obſervations were generally made once in twenty-four hours.

Branxholm is ſituated on the Tiviot, about ten miles from its ſource, and near the ridge from which the country declines toward the eaſt and weſt ſeas. It is about forty-four miles S. W. by W. of Berwick, and thirty-five N. E. of the head of the Solway frith.

Tables are given for every year, having a line for each month, in the ſame manner as an abſtract is given in the following table, for all the years.

Abſtract of all the preceding Years.

Year.	Rain.	Barom.	Therm.	Wind, E^{ly}	W^{ly}
				Days.	
1774,	29.250	29.225		185	180
1775,	38.573	28.956	45.8500	99	266
1776,	26.295	29.147	44.3100	111	225
1777,	29.533	29.133	43.8400	140	225
1778,	36.400	29.035	44.8880	132	233
1779,	31.692	29.125	46.1900	112	253
1780,	25.500	29.085	44.4450	139	227
1781,	29.300	29.185	46.0000	136	229
1782,	38.200	29.061	42.6070	154	211
1783,	31.725	29.107	45.0449	125	240
Medium of 10 Years,	31.648	29.106		133.3	231.9
Ditto, 9 Years			44.7930		

Comparative View of the Depth of Rain at Branxholm, Dalkeith, and Langholm, for five Years.

The rain at all theſe places was meaſured as has been deſcribed above.

	1773.			1774.			1775.			1776.			1777.		
Month.	Dalk.	Branx.	Lang.	Dalk.	Branx.	Lang.	Dalk.	Branx.	Lang.	Dalk.	Branx.	Lang.	Dalk.	Branx.	Lang.
Jan.	3.250	4.100	5.200	4.400	0.300	1.150	3.375	5.350	7.200	0.700	Snow lies		1.025	1.875	0.200
Feb.	1.000	2.375	2.500	2.150	3.425	3.200	2.200	4.600	5.100	3.650	6.870	5.475	0.975	3.383	3.500
March.	1.050	1.350	1.600	0.375	0.750	0.525	0.125	2.450	3.800	1.325	1.375	2.600	1.825	1.550	1.000
April,	2.400	3.200	3.900	1.200	1.900	3.275	0.400	0.700	1.200	0.925	1.550	0.225	3.525	2.825	4.500
May,	1.525	2.000	1.200	1.600	3.450	2.625	1.250	1.475	0.500	0.400	0.725	0.375	0.650	1.800	3.250
June,	1.600	1.125	1.000	3.100	3.600	3.025	0.300	1.500	0.400	1.775	1.375	0.625	1.800	2.450	4.000
July,	1.200	0.752	1.100	1.600	2.450	5.000	6.175	3.573	3.000	2.900	3.425	3.125	2.350	2.050	2.325
Aug.	1.800	1.850	3.425	3.675	4.500	1.450	3.050	4.425	6.000	1.900	2.900	5.225	1.575	2.450	4.250
Sept.	4.425	4.600	8.300	2.350	3.350	5.975	2.825	4.300	4.500	1.675	2.750	5.500	1.750	0.750	2.150
Oct.	1.475	6.125	6.125	1,175	0.950	0.875	6.125	4.550	2.700	1.300	1.800	4.425	4.600	7.400	6.750
Nov.	3.175	1.550	2.900	1.225	2.250	2.100	3.450	4.000	2.200	1.200	2.450	4.225	1.800	2.750	4.650
Dec.	2.575	3.625	1.600	2.125	2.325	2.205	0.275	1.650	2.700	1.900	1.875	2.361	0.950	0.250	0.375

Dalkeith lies 44 Miles N. by E; and Langholm 20 S. by W. from Branxholm.

Reſult

Fig. 1.

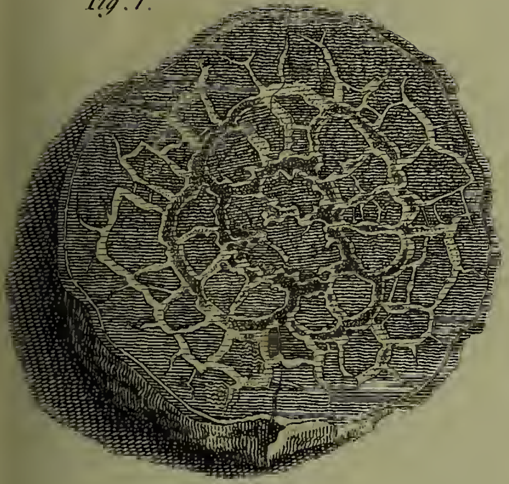


Fig. 2.

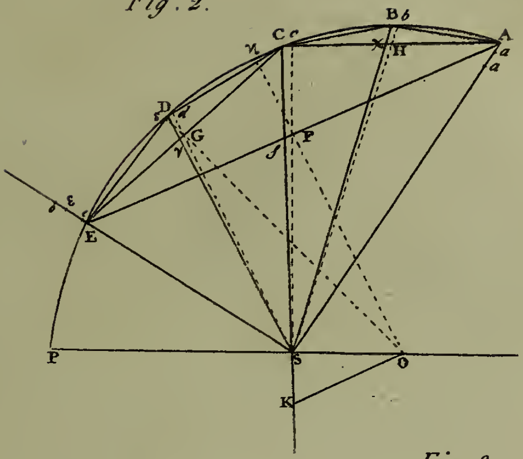


Fig. 3.

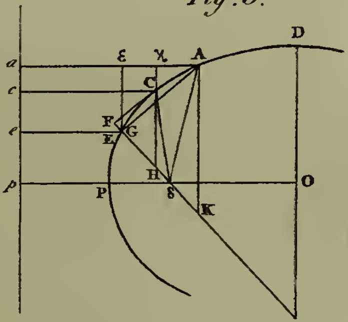


Fig. 4.

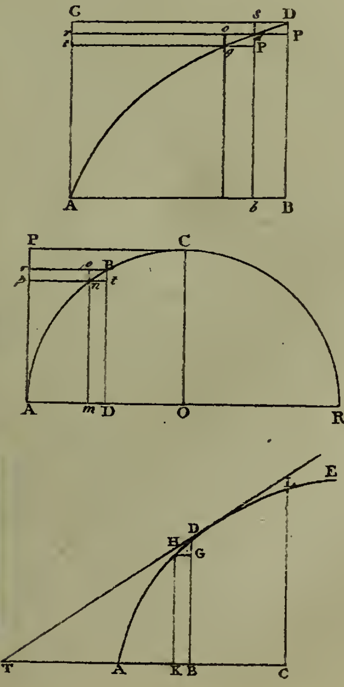
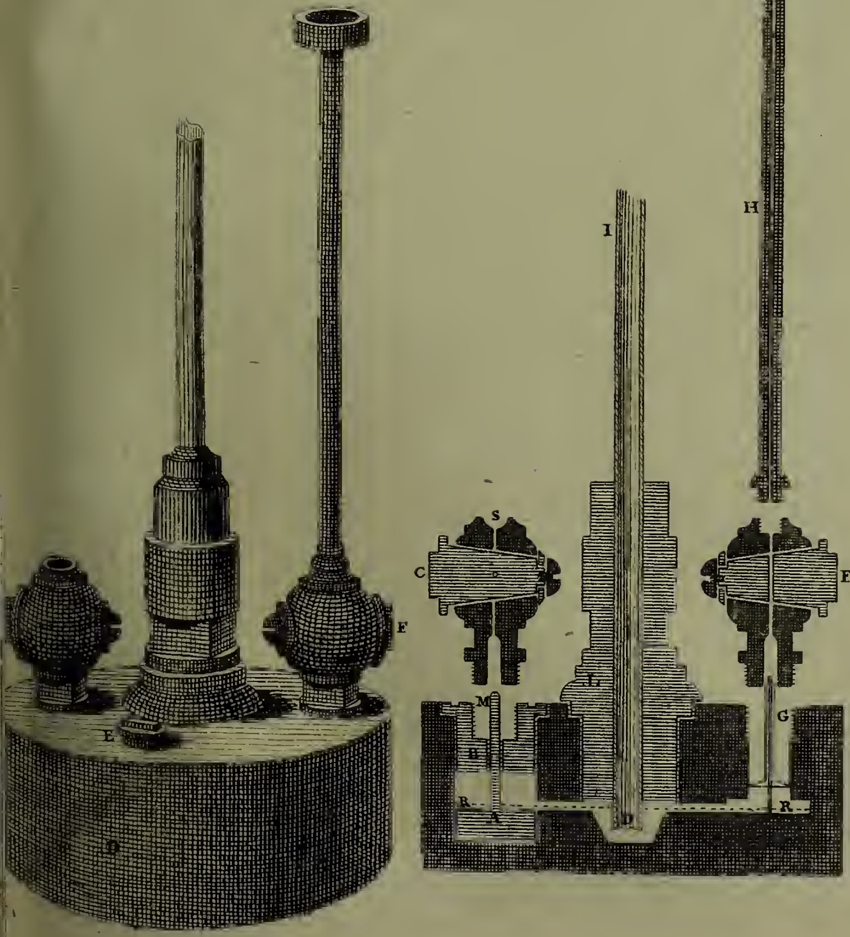


Fig. 5.



Reſult of the preceding compariſon.

Year.	Dalkeith.	Branxholm	Langholm.
1773,	25.473	32.652	38.850
1774,	27.925	29.250	34.405
1775,	29.550	38.573	39.300
1776,	20.650	26.295	34.161
1777,	22.025	29.533	36.950
Medium	25.1246	31.2606	36.7333

X. *Theory of the Earth; or an Inveſtigation of the Laws obſervable in the Compoſition, Diſſolution, and Reſtoration of Land upon the Globe.* By JAMES HUTTON, *M.D. F.R.S. Edin. &c.*

PART I.

" IT is not only by ſeeing thoſe general operations of the globe which depend upon its peculiar conſtruction as a machine, but alſo by perceiving how far the particulars, in the conſtruction of that machine, depend upon the general operations of the globe, that we are enabled to underſtand the conſtitution of this earth as a thing formed by deſign. We ſhall thus alſo be led to acknowledge an order, not unworthy of Divine Wiſdom, in a ſubject which, in another view, has appeared as the work of chance, or as abſolute diſorder and confuſion.

" To acquire a general or comprehenſive view of this mechaniſm of the globe, by which it is adapted to the purpoſe of being a habitable world, it is neceſſary to diſtinguiſh three different bodies which compoſe the whole. Theſe are, a ſolid body of earth, an aqueous body of ſea, and an elaſtic fluid of air.

" It is the proper ſhape and diſpoſition of theſe three bodies that form this globe into a habitable world; and it is the manner in which theſe conſtituent bodies are adjuſted to each other, and the laws of action by which they are maintained in their proper qualities and reſpective departments, that form the theory of the machine which we are now to examine."

Let us begin with ſome general ſketch of the particulars now mentioned.

1ſt, " There is a central body in the globe," which may be conſidered as the ſupport of what is more external and viſible. It has been ſuppoſed ſolid and inert. This is mere conjecture; and after having examined the ſurface more ſtrictly, and formed concluſions concerning changes tranſacted in more central parts, we ſhall probably find reaſon to change this opinion.

2dly, " We find a fluid body of water." This yields the means of life and motion to many animals; is the ſource of the growth and circulation to organized bodies, by being the receptacle of rivers, and the fountain of our vapours.

3dly, " We have an irregular body of land raiſed above the level of the ocean." This is the ſmalleſt but the moſt intereſting part of the globe; for by virtue of this land, animal and vegetable life are ſuſtained.

Laſtly, "We have a ſurrounding body of atmoſphere which completes the globe." There is hardly an operation on the ſurface of the earth which is not conducted or promoted by its means.

The author next takes a ſhort view of thoſe powers by which motion is produced, and activity procured to the mere machine. He then confines his view, more particularly, to that part of the globe which we inhabit.

"A ſolid body of land could not have anſwered the purpoſe of a habitable world; for a ſoil is neceſſary to the growth of plants; and a ſoil is nothing but the materials collected from the deſtruction of the ſolid land. Therefore, the ſurface of this land, inhabited by man, and covered with plants and animals, is made by nature to decay, in diſſolving from that hard and compact ſtate in which it is found below the ſoil; and this ſoil is neceſſarily waſhed away, by the continual circulation of the water running from the ſummits of the mountains towards the general receptacle of that fluid."

Thus the whole ſurface of the earth is in a conſtant ſtate of change. Mountains levelled, and vallies forming out of their ruins, whilſt the moving waters carry part to the deepeſt regions of the ocean. Hence we may foreſee an end to this beautiful fabric; "an end, ariſing from no error in its conſtitution as a world, but from that deſtructability of its land, ſo neceſſary for the œconomy of life and vegetation."

So far the world has been conſidered as a mere machine, conſtructed upon chemical and mechanical principles, and adapted to a particular end. But is it to be conſidered in this view alone? "Or may it not alſo be conſidered as an organized body? Such as has a conſtitution, in which the neceſſary decay is naturally repaired, in the exertion of thoſe productive powers by which it had been formed."

In what follows we are to examine the conſtruction of the preſent earth, in order to underſtand the natural operations of the time paſt, to acquire principles by which we may judge of future events, how the world goes to decay, and by what means it is likely to be renovated.

The ſolid parts of the globe are, in general, compoſed of ſand, of gravel, of argillaceous and calcareous ſtrata, or of theſe combined with other ſubſtances. The firſt is ſeparated by ſtreams and currents, the ſecond is formed by attrition, and the ſtratas of clay and marle formed by depoſition. So far, therefore, we ſee the effects of the water, winds, and tides, in the formation of the earth.

But that which throws moſt light on the origin of the earth is, the immenſe quantity of calcareous matter which belonged to animals, and its connection with the other parts of the land. For it is to be proved, that all theſe calcareous bodies belonged to, and were produced in the ſea.

Marks and remnants of marine animals are found in the moſt ſolid parts of the earth, conſequently thoſe ſolid parts have been formed after the ocean was inhabited by thoſe animals.

The author then continues to proſecute his reſearches into the origin of theſe immenſe ſtrata of calcareous matter, which, whether they be on the top of the Alps or Andes, or in the bowels of the earth, all ſhew unequivocal marks of a marine origin.

The general amount of his reaſoning is this, "that nine tenths, perhaps, or ninety-nine hundredths of this earth, ſo far as we ſee, have been formed by natural operations of the globe, in collecting looſe materials, and depoſiting them at the bottom of the ſea, conſolidating thoſe collections in various degrees, and either elevating thoſe maſſes above the level on which they were formed, or lowering the level of the ſea."

The author neglects the conſideration of the origin and formation of granite, as he does not think it of ſufficient conſequence to lay the foundation for any general rule.

Having thus diſpoſed the whole ſurface of the land under the waters, the next queſtion is, how the continents and high lands have been created.

This involves another queſtion equally curious, namely, the nature of thoſe powers by which the looſe materials, as ſubſiding from the waters, are formed into the moſt perfect ſolid, having no water, nor vacuity, between their conſtituent parts. If this proceſs be carried on at the bottom of the ocean, or in the bowels of the earth, we cannot acquire a true knowledge of its cauſes; but ſtill we have the means of reaſoning from diſtant events, and conſequently of diſcovering the cauſes of thoſe events of which we ſee the effects.

That the nature of the conſolidating power lies beyond the limits of our obſervation is evident; becauſe every conſolidated maſs upon the ſurface of the earth is in a ſtate of decay, although the various natures of thoſe bodies admit of that proceſs in different degrees.*

PART II.

An Inveſtigation of the Natural Operations employed in conſolidating the Strata of the Globe.

There are only two ways in which porous or ſpongy bodies can be conſolidated; the one is ſimple *congelation* from a fluid ſtate, the other is *accretion*, and this includes a ſeparatory operation. Each of theſe proceſſes preſuppoſes fluidity, and that may have taken place either by means of heat, or with the aſſiſtance of a menſtruum.

"The ſtrata at the bottom of the ſea are to be conſidered as having been conſolidated either by aqueous ſolution and cryſtallization, or by the effect of heat and fuſion." The author enters into a minute inveſtigation of theſe points, and rejects the firſt, as being entirely incapable of accounting for all the phænomena; for beſides the difficulty of conceiving how the water contained in the cavities which it has to conſolidate, ſhould be ſeparated in proportion as it performs its taſk, we have other inſurmountable ones to explain, ſuch as the finding many conſolidating matters to be ſuch as are not ſoluble in water; for inſtance, fluors, ſilicious and bituminous matters, metallic ſubſtances, with their endleſs mixtures and ſulphureous compoſitions.

But every difficulty is at once removed, by ſuppoſing conſolidation to be the effects of heat and fuſion. "The looſe and diſcontinuous body of a ſtratum may be cloſed by means of ſoftneſs and compreſſion; the porous ſtructure of the materials may be conſolidated, in a ſimilar manner, by the fuſion of their ſubſtance; and foreign matter may be introduced into the open ſtructure of ſtrata, in form of ſteam or exhalation, as well as in the fluid ſtate of fuſion; conſequently, heat is an agent competent for the conſolidation of ſtrata, which water alone is not. If, therefore, ſuch an agent could be found acting in the natural place of ſtrata, we muſt pronounce it proper to bring about that end."

This opinion is ſupported by an examination of nature. Before entering on this examination, the author obſerves, that there are two different kinds of ſubſtances, *ſilicious* and *ſulphureous*, bodies with which every conſolidated ſtratum of the globe is

intimately

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* Stalactical, and ſome ferruginous concretions, ſeem to form an exception to this. But this objection ariſes from a partial view of things: for the concretion is only temporary, and in conſequence of ſolution, and it is followed by diſſolution, which will be conſidered afterwards.

intimately mixed, or connected. Now there is no proof whatever that any of theſe ſubſtances can either be diſſolved in, or cryſtallized from water. On the other hand, we have many proofs of the penetration of flinty matter in a ſtate of fuſion into other bodies, ſuch as inſulated pieces of flint in chalk or ſand, and foſſil wood penetrated with ſilicious matter.

The next ſtep is to examine ſulphureous ſubſtances with regard to their ſolubility in water, and their power of conſolidating. "Theſe ſubſtances are of two kinds; the one more ſimple, the other more compound," but both inſoluble in water.

The firſt conſiſting of phlogiſton with acids, or metallic matters, ſuch as ſulphur and all metals properly ſo called; the ſecond, oily matters from vegetables, forming mineral bitumens.

With regard to the firſt, no one can ſuppoſe that the mineralizing with ſulphur can be performed by aqueous ſolution, but by heat or fuſion. The author then mentions ſeveral ſpecimens of combinations of metallic ſubſtances with earths and ſpars of different baſis, to ſerve as further proofs of his opinion. He then proceeds to the ſecond ſpecies of inflammable bodies, called oily or bituminous, which are found variouſly mixed with other mineral ſubſtances. Theſe are naturally formed by the proceſs of vegetation, and collected and formed into ſtrata at the bottom of the ſea, where, from the effects of heat, they are more or leſs changed. The moſt common cauſe of this change is evaporation or diſtillation of their more volatile parts. This is ſupported by every appearance of theſe ſubſtances, for all the parts are often found ſeparate.

Hitherto the arguments employed for proving conſolidation to be the effects of heat and fuſion, have been chiefly taken from the inſolubility of the conſolidated ſubſtances in water. "But there are found in the mineral kingdom many ſolid maſſes of ſal gem, which is a ſoluble ſubſtance." How does this affect the preſent theory? The author examines the appearance of the ſalt rock in Cheſhire, which lies in ſtrata of red marle, with which it is variouſly tinged. This colouring matter obſerves a certain regularity in its ſeparation, and "gives to the perpendicular ſection of the rock a diſtinguiſhable figure in its ſtructure." Towards the bottom only it had a ſtratified appearance; at the top it was all compoſed of concentric circles, which appeared like the ſection of a moſs, altogether compoſed of concentric ſpheres, like what we often ſee in agates. This appearance is altogether inexplicable on any other principles than thoſe of perfect fluidity, or fuſion of the ſalt, and the attractions and repulſions of the contained ſubſtances. This is further confirmed by the deſcription of an alkaline ſalt found in a mineral ſtate, an account of which is publiſhed in the Philoſ. Tranſ. for 1771. In addition to this, many other facts might be added, but there is one which is peculiarly diſtinct, and allows an accurate deſcription. It is a ſpecies of iron ſtone, commonly found in argillaceous ſtrata, attendant on coal, both in England and Scotland. The ſpecies which the author deſcribes is found at Aberlady, in Eaſt Lothian; and as he eſteems it much as a teſtimony of the truth of his opinions, we give the deſcription of it in his own words.

"The form of theſe iron ſtones is that of an oblate or much compreſſed ſphere, and the ſize from two or three inches diameter to more than a foot. In the circular or horizontal ſection, they preſent the moſt elegant ſeptarium. (Plate XI. Fig. 1.) and, from the examination of this particular ſtructure, the following concluſions may be drawn.

1*ſt*, "That the ſepta have been formed by the uniform contraction of the internal parts of the ſtone, the volume of the central parts diminiſhing more than that of the circumference; by this means, the ſeparations of the ſtone diminiſh in a progreſſion from the centre towards the circumference.

2*dly*, "That there are only two ways in which the ſepta muſt have received the ſpar with which they are filled, more or leſs; either, 1*ſt*, by inſinuation into the cavity of the ſepta after theſe were formed; or, 2*dly*, by ſeparation from the ſubſtance of the ſtone, at the ſame time that the ſepta were forming.

"Were the firſt ſuppoſition true, appearances would be obſervable, ſhewing that the ſparry ſubſtance had been admitted, either through the porous ſtructure of the ſtone, or through proper apertures communicating from without. Now, if either one or other of theſe had been the caſe, and that the ſtone had been conſolidated from no other cauſe than concretion from a diſſolved ſtate, that particular ſtructure of the ſtone, by means of which the ſpar had been admitted, muſt appear at preſent upon an accurate examination.

"This, however, is not the caſe, and we may reſt the argument here. The ſepta reach not the circumference; the ſurface of the ſtone is ſolid and uniform in every part; and there is not any appearance of the ſpar in the argillaceous bed around the ſtone.

"It therefore neceſſarily follows, that the contraction of the iron ſtone, in order to form ſepta, and the filling of theſe cavities with ſpar, had proceeded *pari paſſu*; and that this operation had been brought about by means of fuſion, or by congelation from a ſtate of ſimple fluidity and expanſion."

There is another fact worthy of attention. It is the cryſtallizations in the cavities of cloſe bodies, ſuch as in thoſe balls of hollow agate found in general near Deux-Ponts.

From the examination of a number of thoſe bodies the following concluſions are drawn:

1*ſt*, "That concretion had proceeded from the ſurface inwards," the figure of the external coats always determining thoſe within, and never the contrary.

2*dly*, That the cavity contains nothing which did not exiſt when the agate was formed.

3*dly*, That the contents muſt have been in a fluid ſtate.

Laſtly, That as this fluid ſtate could not have been the effect of ſolution in a menſtruum, it muſt have been from heat and fuſion.

The evidence for this univerſal application of ſubterraneous heat, in the fuſion of all mineral bodies, having been conſidered, we are next to give examples of ſtrata conſolidated without the introduction of foreign matter, merely by the fuſion of their own materials. For this purpoſe the ſiliceous and calcareous ſeem the moſt proper for inveſtigation, as being the moſt abundant. Of the firſt kind there are every where innumerable examples, which it is needleſs to deſcribe. Of the ſecond, which is not ſo common, the author takes the Spaniſh marble as an example. This marble is compoſed of fragments of other marbles, among which are ſome oolite and ſome ſhell marble. That this compound has been conſolidated by fuſion, he thinks is proved by this; that beſides the general conformation of thoſe hard bodies, ſo as to be perfectly adapted to each other's ſhape, there is a mutual indentation of the different pieces of gravel into each other, exactly reſembling the *ſutures* in the *cranium*.

The next point is to prove that this operation was univerſal in conſolidating the whole earth in the various degrees. This is exemplified by chalk, which is to be found in all gradations from marble to looſe chalk. In this general account one body *(granite)* ſeems to have been omitted. That this has once been in a ſtate of fuſion, he proves by the appearances of one ſpecies of it found near Portſoy, in the road to Huntly.

" Upon the whole (he adds) whether granite be conſidered as a ſtratum or irregular maſs, whether as a mixed, or as the ſeparation of ſubſtances which had been mixed, there is ſufficient proof of its having been conſolidated by means of fuſion, and in no other manner."

What the author conſiders as another clear and deciſive teſtimony of the truth of his opinion, is, the formation of veins or fiſſures, which he conceives to have happened from the unequal degrees of contraction in the cooling of the conſolidated maſſes, and which are not to be accounted for on the ſuppoſition of ſolution.

PART III.

Inveſtigations of the Natural Operations employed in the Production of Land above the Surface of the Sea.

It is certain that our higheſt lands ſhow marks of their having been once at the bottom of the ſea, therefore, in explaining this, we have no alternative, but either to ſuppoſe ſtrata elevated by the power of heat above the level of the preſent ſea, or the ſurface of the ocean reduced many miles below the height at which it had been during the formation of the land which we inhabit.

If the ſtrata which are framed at the bottom of the ſea, and which were neceſſarily horizontal, be erected with an expanſive power acting below, we may expect to find every ſpecies of fracture, diſlocation, and contortion, in thoſe bodies: now this is actually the caſe with the ſtrata of the globe.

We are to conclude, therefore, that the land which we inhabit has been elevated by the ſame power that conſolidated it. " This agent is matter actuated by extreme heat, and expanded with amazing force."

In this caſe, ſome of the expanded matter might be expected to be found condenſed in the bodies which have been heated by the igneous vapours, and the foreign matter thus introduced into the fractures and ſeparations of theſe maſſes. Hence the origin of all metallic veins. Theſe are to be conſidered as in relation to their form, and in relation to their contents. They differ from the fiſſures of conſolidated ſtrata in this, that they appear to have been cauſed by ſome extrinſic cauſe, and are mere fractures and diſlocations; whereas the other has ariſen from a cauſe in the body itſelf, the irregular contraction of the fluid maſs.

Beſides the appearance, the contents indicate the exertion of heat, for they are all of the nature of thoſe which, in the former part of the paper, were conſidered as being inſtrumental in the conſolidation of ſtrata.

Speaking of the force of this general cauſe, the author ſays, " When fire burſts forth from the bottom of the ſea, and when the land is heaved up and down, ſo as to demoliſh cities in an inſtant, and ſplit aſunder rocks and ſolid mountains, there is no one but muſt ſee in this a power which may be ſufficient to accompliſh every view of nature in erecting land, as it is ſituated in the place moſt advantageous for that purpoſe."

Are theſe operations of heat accidental? Or are they conſtant and natural to the globe for the production of land? The anſwer is plain: "They remain at preſent with undiminiſhed activity, or in the fulneſs of their power."

PART IV.

Syſtem of Decay and Renovation in the Earth.

"It is neceſſary for a living or inhabited world, that this ſhould conſiſt of land and water. It is alſo neceſſary, that the land ſhould be ſolid and ſtable, reſiſting, with great power, the violent efforts of the ocean; and, at the ſame time, that this ſolid land ſhould be reſolved by the influence of the ſun and atmoſphere, ſo as to decay, and thus become a ſoil for vegetation. But theſe general intentions are perfectly fulfilled in the conſtitution of our earth, which has been now inveſtigated. This great body being formed of different mixed maſſes, having various degrees of hardneſs and ſolubility, proper ſoil for plants is ſupplied from the gradual reſolution of the ſolid parts; fertility in thoſe ſoils ariſes from the mixture of different elementary ſubſtances; and ſtability is procured to that vegetable world, by the induration of certain bodies, thoſe rocks and ſtones, which protect the ſofter maſſes of clay and ſoil."

In this manner alſo may be explained thoſe natural appearances which diverſify the earth for the uſe of organized living bodies. Such are the diſtinctions of mountains, lakes, valleys, rivers, &c. All theſe are the effects of ſteady cauſes.

The next object of enquiry is, the nature of thoſe operations of the globe, during the time that the preſent earth was forming at the bottom of the ſea, and what the ſource of all thoſe materials is from which the ſolid land has been formed.

From examining the materials of which the different ſtrata of the earth are formed, ſuch as the calcareous part, the gravel and ſand, or ſiliceous, and the clay, or argilaceous, Dr. Hutton thinks we have reaſon to conclude, that, during the time this land was forming by the collection of its materials, there muſt have been a former land containing ſimilar materials. But what chiefly tends to illuſtrate this, is, that there had then been a race of animated beings, which propagated their ſpecies, and which have continued to this day. Of the exiſtence of theſe animals, there are plenty of well known proofs. But vegetables are neceſſary for the exiſtence of animals; theſe, therefore, muſt alſo have exiſted. And of this we have frequent evidence, in the ſpecimens of foſſil wood, and the impreſſions of leaves and other parts of plants.

Having thus aſcertained the exiſtence of a former, as well as the production of the preſent earth, it is evident that there are two operations neceſſarily conſecutive. The formation of the preſent earth neceſſarily involves the deſtruction of continents in the old world.

The next object of enquiry which the author conſiders, is the time neceſſary for theſe great changes. Now the formation of the future land can never be inveſtigated, as its operations lie beyond the evidence of our ſenſes. But it is not ſo with the decay, which he concludes from the examination of rocks, iſlands, and iſthmuſes, &c. deſcribed in the time of the Greeks and Romans, and ſtill extant; he concludes, we ſay, that this decay is ſo extremely ſlow, that we cannot find a meaſure of the quantity, in order to form an eſtimate.

"We have now got to the end of our reaſoning; we have no data further to conclude immediately from that which actually is. But we have got enough; we have the ſatisfaction to find, that in nature there is wiſdom, ſyſtem, and conſiſtency. For having, in the natural hiſtory of this earth, ſeen a ſucceſſion of worlds, we may from this conclude that there is a ſyſtem in nature; in like manner as, from ſeeing revolutions of the planets, it is concluded, that there is a ſyſtem by which they are intended to continue thoſe revolutions. But if the ſucceſſion of worlds is eſtabliſhed in the ſyſtem of nature, it is in vain to look for any thing higher in the origin of the earth. The reſult, therefore, of our preſent enquiry is, that we find no veſtige of a beginning—no proſpect of an end."

XI. *The Orbit and Motion of the Georgium Sidus, determined directly from Obſervations, after a very eaſy and ſimple Method.* By John Robison, *M. A. of Edinburgh.*

THE author gives a ſhort hiſtory of the diſcovery of the planet Herſchel, and the obſervations made on it by various aſtronomers, which it would be unneceſſary to notice again here, as the reader has already ſeen a much fuller account from the Bruſſels Tranſactions.* Mr. Robiſon did not obtain a ſight of it till Auguſt 1782; and in the ſpring of 1784, he framed a ſet of elements, which correſponded with the obſervations made at that time with abundant accuracy. He waited, however, till a fifth oppoſition in the year 1786 ſhould enable him to determine the elements with greater certainty. The reſult is now laid before the public, and he is convinced, that if we do not admit the planet to be the ſame with 964 of Mayer, near half a century muſt elapſe before the elements can be ſo accurately aſcertained as in the caſe of the other planets.

The times and apparent longitudes and latitudes of Herſchel, in its oppoſitions to the ſun, are expreſſed in the following table.

	M. T. Ed.	Long.	Lat. N.
	h. ′ ″	*s.* ° ′ ″	′ ″
1781. December 21.	17..44..33	3..00..52..11	15..07
1782. December 26.	08..56..56	3..05..20..29	18..56
1783. December 31.	00..46..24	3..09..50..52	22..10
1785. January 3.	17..28..56	3..14..23..02	25..40
1786. January 8.	10..39..31	3..18..57..05	28..52

This table is made from the author's obſervations, combined with thoſe of Maſkelyne and Slop, and the following method was taken to get rid of the inaccuracy, to which each was liable. Since the ſquares of the angular motions are inverſely as the cubes of the diſtances, by the arch deſcribed between any two ſucceſſive oppoſitions, a pretty near approximation is made to the planet's diſtance from the ſun. The heliocentric angular motion at any oppoſition is nearly a mean between the angular motions, with which the arches, intercepted between it and the adjacent oppoſitions, would be uniformly deſcribed. Thus the heliocentric angular motion at the three intermediate oppoſitions is obtained. The angular velocities at the two extreme oppoſition poſitions were determined, by ſuppoſing that the changes of angular velocity followed a regular law. Thus the geocentric motion for a few days before and after oppoſition was determined, and conſequently from each obſervation the preciſe time and place, when the planet would be in oppoſition. Theſe determinations differed in no caſe from each other 10″, and as the aſſumptions from the combination of obſervations could not produce an error of 2″, the means of theſe determinations were taken for the places of the planet in its oppoſitions.

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* In the Tranſactions above alluded to the three names Uranus, Herſchel and Georgium Sidus, are mentioned as given to this planet in various places.

For the planet's place compared with any fixed ſtars, Mayer's catalogue was uſed, ſo that if this theory ſhould be compared with any obſervations, where the ſtar's place is deduced from Bradley's or De la Caille's catalogues, the longitude will be found about 6″ too ſmall, or as much too great.

From the table above, were eaſily determined the

Long. Node, Jan. 1, 1786 ——— ———	2*s*..12°..48′..45″.
Inclin. Orbit ——— ——— ———	46..26

The 31ſt of December, 1783, was then taken as an epoch, between which and the preceding oppoſition was 369*d*..15*h*..49′..28″. This time counted back, came within a few minutes of the oppoſition in 1781, and by means of the heliocentric motion, the place of the planet was computed for the beginning of this interval. In like manner its place was computed for two equal intervals of 369*d*..15*h*..49′..28″ from the epoch, and there were obtained four angles in the orbit deſcribed in equal times.

The difference of theſe angles ſhewed the inequality of the angular motion, from which the elements of the orbit were to be diſcovered. But as theſe differences do not exactly agree with the planet's motions, ſome corrections muſt be made for the inaccuracy of the obſervations. For thoſe of Maſkelyne and Slop, the author preſumes that 5″ may be allowed, and 10″ for his own.

By Slop's obſervations, the planet was ſtationary on, 1782, March, 6*d*..6*h*..14′..56′ M. T. Greenwich, its apparent longitude being 2*s*..28°..49′..27″. The five obſerved oppoſitions give the firſt and ſecond differences of the heliocentric motion at theſe oppoſitions, and by the uſual methods of interpolation, the heliocentric place of the planet at the above-mentioned time is found to within 2″. By comparing this with the geocentric place, the diſtance from the ſun is found = 18,9053. By a ſimilar interpolation for March 7*d*..6*h*..14′..56″, we have another heliocentric place, and the difference between the two places = 43″,4365 = diurnal heliocentric motion. A planet moving in a circle whoſe radius = 18,9053 has a diurnal motion = 43″,1647.

Hence the planet's diſtance is leſs than half the parameter of its orbit, and the true anomaly more than 90°,* and as at the oppoſition 1785, it had not arrived at its perihelion, the differences of the arches deſcribed in equal times form a ſeries continually decreaſing.

From the obſervation of the planet in the ſtationary point, its angular velocity is not much greater, than if it revolved in a circle, and by Maſkelyne's obſervations the heliocentric motion in April 1781, did not much exceed the motion in a circle at the ſame diſtance, and conſequently its true anomaly does not much exceed 90°. Hence we may give to the ſecond difference a ſmall increaſe, and to the firſt difference a ſmall diminution, by a correction not exceeding 3″ in any of the obſervations. The firſt obſervation has its longitude diminiſhed 1″, the ſecond and third increaſed 2″½, the fourth and fifth increaſed 3″. The times correſponding to theſe intervals, and the correſponding corrected longitudes cleared from the effects of aberration and mutation, and reduced to the orbit and epoch of oppoſition 1783, are as follow:

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* The angular velocity of a body in an ellipa is to that in a circle at the ſame diſtance in the ſubduplicate ratio of half the parameter to the diſtance.

		Mean time Greenwich. h. ′ ″	s. ° ′ ″
1781.	December 21,	17..20..17	3..00..53..50
1782.	December 26,	09..09..45	3..05..21..16,5
1783.	December 31,	00..59..13	3..09..50..37,5
1785.	January 3,	16..48..41	3..14..21..52
1786.	January 8,	08..38..09	3..18..54..58

Hence the following intercepted arches with their firſt and ſecond differences,

° ′ ″	′ ″	″
4..27..26,5		
	1..54,5	
4..29..21		1
	1..53,5	
4..31..14,5		2
	1..51,5	
4..33..06		

From theſe data the elliptical orbit of the planet is conſtructed by the following method, both ſimple, and ſuſceptible of great accuracy.

Let ACP (Plate XI, Fig. 2.) be the planet's elliptical orbit, S. the focus, P the center, A.B.C.D.E. places of oppoſition, draw the chords AB, BC, CD, DE, and radii vectores AS, BS, CS, DS, ES. The chords may be ſuppoſed to be biſected in χ and γ by the radii, and the elliptical ſectors ABS, BCS being nearly equal, B is nearly the place of the planet at its ſecond oppoſition.

Let ASB $= u$, BSC $= v$, CSD $= x$, DSE $= y$, ASC $= w$, CSE $= z$, AχS $= \chi$, CγS $= \gamma$.

$$AS : A\chi :: \text{ſin. } \chi : \text{ſin. } w.$$
$$A\chi : CS :: \text{ſin. } v : \text{ſin. } \chi.$$
$$\therefore AS : CS :: \text{ſin. } v : \text{ſin. } w.$$
$$ES : CS :: \text{ſin. } x : \text{ſin. } y.$$

From theſe proportions by 21ſt prop. B 1. of Newton's Principia the ellipſe may be conſtructed. Its ſemitranſverſe axis will be about nineteen times the earth's diſtance from the ſun, its excentricity $\frac{1}{20}$ of it, and PSC = 73′. By this we may diſcover the errors ariſing from ſuppoſing the ſectors equal when Aχ = χC.

Biſect AE in F, draw OF$\varkappa$, SFc, make $\varkappa$c : Cc : : cS : cF draw CφS, and draw OK parallel to AE. $\varkappa$C may be eſteemed parallel to EA. The ſegments E$\varkappa$G = F$\varkappa$A and triangle EFS = FSA $\therefore$ E$\varkappa$FS = $\varkappa$FSA, but triangle $\varkappa$CG = CcS $\therefore$ ſector ACS = CSE and C is the place of the planet at the third oppoſition. cF = V. ſine of cA, an arc of about 9°, and therefore about $\frac{1}{80}$ of cS. $\varkappa$C : cF : : OK : KF $\therefore$ $\varkappa$c = $\frac{1}{20}$ cF nearly, or $\frac{1}{1600}$ cS. Cc = $\frac{1}{80}$ $\varkappa$c = $\frac{1}{128000}$ cS $\therefore$ CSc does not exceed 2″. BSb, DSd do not exceed $\frac{1}{8}$ of a ſecond. For BS, CS, DS being nearly equal, and bH, dG nearly $\frac{1}{4}$ cF, Bb and Dd = $\frac{1}{16}$ Cc nearly.

The error in this ſimple conſtruction may be corrected by the following conſiderations. The triangles $\varkappa$Fc, δGd are nearly ſimilar $\therefore$ cF : dG : : AG^2 CE^2 and $\varkappa$cF : δGd

$\delta Gd :: AE^4 : CE^4$. $Sc = Sd$ nearly $\therefore Cc : Dd$, (or $\varphi F : \gamma G$) $:: AG^4 : EC^4$ but $AE = 2CE$ nearly $\therefore \varphi F : \gamma G$ and $\varphi F : \chi H :: 1C : 1$ nearly.

$$\begin{aligned} CS &: C\gamma :: \text{ſin}\ \gamma : \text{ſin}\ x \\ C\gamma &: E\gamma :: C\gamma : E\gamma \\ E\gamma &: ES :: \text{ſin}\ y : \text{ſin}\ \gamma \\ \therefore CS &: GS :: C\gamma \times \text{ſin}\ y : E\gamma \times \text{ſin}\ x \\ \text{Let } CS &: eS :: \text{ſin}\ y : \text{ſin}\ x \\ \therefore ES &: ES :: E\gamma : C\gamma \\ \text{and } ES &: Ee :: E\gamma : C\gamma - E\gamma : E\gamma : 2\gamma G. \end{aligned}$$

In like manner make $CS : aS :: \text{ſin}\ w : \text{ſin}\ v$, then $AS : Aa :: A\chi : 2\chi H :: E\gamma : 2\gamma G$ and $Ee : Aa :: ES : AS$ nearly $\therefore Ee = Aa$ nearly.

$$\begin{aligned} \text{Make } AS &: So :: \text{ſin}\ z : \text{ſin}\ w \\ \text{but } SE &: AS :: E\varphi \times \text{ſin}\ w : A\varphi \times \text{ſin}\ z \\ \therefore SE &: So :: E\varphi : A\varphi \\ \text{and } SE &: Eo :: E\varphi : A\varphi - E\varphi :: A\varphi : 2\varphi F \text{ nearly} \\ \text{or } SE &: Eo :: 2E\gamma : 32\gamma G :: E\gamma : 16\gamma G \text{ nearly} \\ \text{Hence } Eo &= 8Ee \text{ nearly} \end{aligned}$$

Make $AS : S\varepsilon :: \text{ſin}\ z : \text{ſin}\ w$, then $aS : S\varepsilon :: AS : So$, and $Aa : \varepsilon o :: AS : SE$ $\therefore \varepsilon o = Aa$ or Ee nearly $\therefore e\varepsilon = 6Ee$ nearly.

Hence for approximating to the true ratios of AS and GS to CS

$$\begin{aligned} \text{Make } CS &: aS :: \text{ſin}\ w : \text{ſin}\ v \\ CS &: eS :: \text{ſin}\ y : \text{ſin}\ x \\ eS &: \alpha S :: \text{ſin}\ w : \text{ſin}\ z \\ aS &: \varepsilon S :: \text{ſin}\ z : \text{ſin}\ w \end{aligned}$$

Make $AS = aS + \frac{a\alpha}{6}$. $ES = eS - \frac{e\varepsilon}{6}$. Then A, C, E will be in the circumference of an ellipſe, whoſe focus is S, center O, and having the ſectors ASC, CSE nearly equal.

The approximation will be much eaſier, and almoſt as accurate, by adding $\frac{1}{6}$ (Log. aS − Log. αS) to Log. aS for Log. AS and ſubtracting $\frac{1}{6}$ (Log. εS − Log. eS) from Log. eS for Log. ES. Or by adding $\frac{1}{6}$ (Log. eS − Log. εS) to Log. aS, and ſubtracting it from Log. eS.

The following Theorem may be of uſe for conſtructing the ellipſe, and, I believe, is new:

Let DAP be an ellipſe, (Plate XI. fig. 3.) of which O is the centre, S the focus, and ap the directrix; from any three points A, C, E, draw lines Aa, Cc, Ee, perpendicular to the directrix; draw the radii AS, CS, ES; draw AK, ϰCH, and εE, perpendicular to Aa, and AG, CF, perpendicular to ES, and Sp perpendicular to ap.

Let AS be $= a$, CS $= c$, ES $= e$; the angle ASE $= x$, CSE $= y$, and ESP $= z$.

It is evident that $EH : EK = \varepsilon\kappa : \varepsilon A$, $= CS - ES : AS - ES$, $= c - e : a - e$; alſo, $SF = c.\mathit{coſ}, y$, $SG = a.\mathit{coſ}, x$, $CF = c.\mathit{ſin}, y$, and $AG = a.\mathit{ſin}, x$; alſo, the angle FCH $=$ GAK, $=$ ESP, $= z$.

Therefore, $FH = CF.\mathit{tan}, z$, $= c.\mathit{ſin}, y.\mathit{tan}, z$, and $GK = a.\mathit{ſin}, x.\mathit{tan}, z$; therefore ſore $EH = e - c.\text{coſ}, y + c.\text{ſin}, y.\tan, z$, and $EK = e - a.\text{coſ}, x + a.\text{ſin}, x.\tan, z$; thereſore, $c - e : a - e = e - c.\text{coſ}, y + c.\text{ſin}, y.\tan, z : e - a.\text{coſ}, x + a.\text{ſin}, x.\tan, z$, and $(c-e).(e - a.\text{coſ}, x) + (c-e).\ a.\text{ſin}, x.\tan, z = (a-e).(e - c.\text{coſ}, y) + (a-e).c.\text{ſin}, y.\tan, z$. This gives

$$Tan.\ z = \frac{(c-e).(e - a.\text{coſ}, x) - (a-e).(e - c.\text{coſ}, y)}{c.(a-e)\ \text{ſin}, y - a.(c-e).\ \text{ſin}, x}$$

Or, more conveniently for logarithms,

$$Tan.\ z. = \frac{c.(a-e).\ \text{coſ}, y - a.(c-e)\ \text{coſ}, x - e.(a-c)}{c.(a-e).\ \text{ſin}, y - a.(c-e).\ \text{ſin}, x}$$

Then, by the common theorems, we have the excentricity $\varepsilon = \frac{a-e}{e.\text{coſ}, z - a\ \text{coſ}, (x+z)}$ the mean diſtance being = 1. The aphelion and perihelion diſtances are $1+\varepsilon$ and $1-\varepsilon$. By their means, we obtain the mean anomalies correſponding to the true anomalies OSA and OSE. The difference of the mean anomalies is to 360°, as the time between the appulſes of the planet to the points A and E to the time of a ſydereal revolution. The ſquare of a ſydereal year is to the ſquare of the time of this revolution, as 1 to the cube of the planet's mean diſtance from the ſun.

This proceſs gives us the following elements:

Mean diſtance,		19,08247
Excentricity,		0,9006
Periodic time,		83,359 Years.
		s. ° ′ ″
Mean Anomaly at E,		4. 00. 32. 51
Longitude of the Aphelion,	for the Epoch 1783, Dec. 31.	11. 23. 09. 51
Longitude of the Node,		2. 12. 46. 14
Inclination of the Orbit,		00. 00. 46. 25

Theſe elements agree with the obſervations, and comparing them with Mayer's obſervations on the ſtar, No. 964, the planet was calculated to be only 3′ 52″ to the weſt, and 1″ to the north of the ſtar, which appears therefore to be the ſame with the planet. Had the ſecond differences of the arches been aſſumed conſtant, the elements would have agreed with thoſe made on the preſumption that No. 964 was the planet, and there would have been an alteration only of one ſecond in any of the places above uſed.

The following elements were made on a correction of the obſervations, which produced a ſeries of ſecond differences, decreaſing as rapidly as was conſiſtent with the probable inaccuracy of the obſervations.

Mean diſtance,		19,18254
Excentricity,		0,88461
		s. ° ′ ″
Mean longitude,	1786, January 1 M. T. Greenwich	3..23..17..03
Longitude of Aphelion,		11..17..32..54
Periodic time,		84y..6d..4h..48

Theſe elements agree with the late obſervations, as well as with thoſe of Mayer, but compared with the ſtation in March 1782, there is a difference in the angular motion from that by interpolation, ſhewing that the mean diſtance is too great.

The following elements were made on a ſuppoſition, that No. 964 was the planet, about two years ago, and there has not appeared ſince any reaſon to make a change, except in the inclination of the orbit, which may perhaps be increaſed about 10″.

Mean diſtance - - - - - - - -	19,0858
Excentricity, - - - - - - - -	0,90737
	s. ° ′ ″
Mean longitude, 1786. January 1. Noon M. T. G. - -	3..23..41..13
Longitude of the Aphelion, - - - - -	11..23..10..38
Longitude of the Node, - - - - - -	2..12..48..45
Inclination of the Orbit, - - - - - -	46..26
Periodic time in days - - - - -	30456*d*..1*h*..40′..48″
Mean diurnal motion - - - - - -	42″,551

The elements, formed on the moſt rapid decreaſe of the ſecond differences, do not admit the ſuppoſition of the ſtar, No. 34. Tauri, in the Britannic catalogue, being the planet; for though the diſtance weſtward is only 40″, or perhaps only 12″, there is a difference of latitude of more than two minutes. Beſides, if compared with the ſtations in October 1781, and March and October 1782, they give the geocentric longitude conſiderably too great in the ſpring, and too ſmall in the autumn.

Elements, formed by interpolating heliocentric places for the times of vicinity to the ſtationary points, and comparing them with the geocentric places, as alſo by the three oppoſitions obſerved in January 1784, coincided almoſt perfectly with the above.

Tables are ſubjoined for computing the motion of this planet; but as the attention of aſtronomers has been given to this object for ſeveral years ſince their formation, it will not be thought neceſſary to inſert them here.

XII. *Abſtract of a Regiſter of the Weather, kept at Hawkhill, near Edinburgh, containing Obſervations of the Thermometer, the Quantity of Rain and Evaporation, from* 1771 *to* 1776, *incluſive. Communicated by Mr.* MACGOWAN.

THE mean of the thermometer is given for the half of each month, the quantities of rain and evaporation for each month. Hawkhill is 1½ mile N. E. of Edinburgh. The thermometer is noted every day at 8 o'clock, A. M.

Underneath is a Table of the Sums and Means for each year.

Therm.	1771 Rain	Evap.	Therm.	1772 Rain.	Evap.
Sums Means 45,85	22,194	24,544	45,53	32,184	23,558
Sums Means 46,08	1773 28,842	31,922	44,86	1774 30,185	30,093
Sums Means 47,08	1775 34,298	30,754	45,84	1776 26,093	

Medium of heat for the ſix preceding years 45,06.

Greateſt Degrees of Cold and Heat, obſerved at Hawkhill, from 1766 to 1776, incluſive.

		Fahr. Therm.
1767. January 17.	at 8½ h. P. M.	17.50
1768. January 3.	at 10 h. P. M.	17.00
17.	at 8 h. A. M.	17.00
1772. February 1.	at 7¾ h. A. M.	12.00
	N. B. At Selkirk the thermometer, ſame morning, continued from 6 h. to 8 h A. M.	1.50
1774. January 12.	at 7 h. A. M.	17.00
	N. B. Selkirk at 8 h. A. M.	12.00
	And the preceding night at 12 h.	8.00
1776. January 31.	at 8 h. A. M.	14.00
	Same h. at Obſervatory, Hawkhill,	11.00
	At Botanic garden, at 6 h. A. M. ſaid day,	5.00
1770. Auguſt 5.	at 3½ h. P. M.	81.15

Proportion of the Weſt Wind to the Eaſt for every Month, deduced from Obſervations made at Hawkhill from 1764 to 1771, both incluſive.

N. B. The South Winds, and all to the Weſt of the Meridian, are reckoned Weſt. The North Winds, and all to the Eaſt of the Meridian, are reckoned Eaſt.

Months	W. wind.	E. wind.	Months.	W. wind.	E. wind.
January,	22.0	9.0	July,	17.9	13.1
February,	18.6	9.6	Auguſt,	21.3	9.7
March,	17.6	13.4	September,	20.4	9.6
April,	15.9	14.1	October,	23.9	7.1
May,	14.5	16.5	November,	22.0	8.0
June,	15.6	14.4	December,	20.0	11.0
For the whole year, 229.7 Weſt, 135.5 Eaſt.					

LITERARY CLASS.

I. *Eſſay on the Origin and Structure of the European Legiſlatures.* By ALLAN MACONOCHIE, *Eſq.*

THE firſt part of this eſſay treats of *the period previous to the Conqueſt of the Weſtern Empire.* The introduction begins by obſerving, that the fall of the feudal ſyſtem was accompliſhed in the principal ſtates of Europe, at a period when learning began to revive, and as the kings conducted the attack on the privileges of the nobility, moſt of the ſpoils fell to their ſhare. Men then began to ſpeculate on theſe events, and the rights of kings, nobles, and people, became matter of diſcuſſion. The chief queſtion diſputed was, What conſtitution was adopted by the original founders of each nation?

The firſt reſearches were therefore made to ſupport the tenets of each faction; ſome aſſerted the abſolute power of kings, and the right of conqueſt; others the rights of the people; and others the cauſe of ariſtocracy, and the influence of their opinions is ſtill ſenſible.

Mr. Maconochie ſuggeſts, that there muſt have been ſome foundation in truth for the different opinions which have been adopted, and ſome evidence to ſupport each of them; that all the ſyſtems, excluſive of the others, are erroneous; and that ſome hypotheſis may be diſcovered which will ſolve every difficulty.

One practice mentioned by Cæſar and Tacitus, leads him to conclude, that this hypotheſis was ſimple. No excluſive property exiſted in land, therefore the laws could not be numerous, nor the government complicated.

It will, however, be neceſſary to enquire what was the ſtructure of ſociety among the Gothic nations. At the commencement of hiſtory, we find the riſing republics near the Mediterranean, had made ſome farther advances in government than the inland nations. Gaul and Britain, in Cæſar's time, were a tranſcript of Greece, Italy, and Spain, when eſtabliſhing their republics; Germany was ſtill ruder, and Finland, Caledonia, &c. little different from a North American wilderneſs. Before the fall of the Weſtern Empire theſe countries became formidable.

Mean time the feudal law began to appear among the Franks. They found riches in Gaul, and the opulent began to extend their houſeholds and engage retainers, by which the perſonal relation of patron and client, and laws already uſed as a means to purchaſe retainers, came alſo to be employed in conſtituting this relation. This was at firſt perſonal and temporary, but afterwards became hereditary and real. Martel introduced them, and they grew into the conſtitution of the ſtate. Charlemagne introduced them into Catalonia, and they ſoon found their way through Spain. The Anglo-Saxons had been accuſtomed to the relation of vaſſalage, and received the feudal laws at the eſtabliſhment of the Normans. The northern nations, ſays Mr. Maconochie, received the feudal law from their more poliſhed neighbours, but with many reſtrictions. If theſe obſervations are juſt, Mr. Maconochie thinks that the riſe of the conſtitutions of the Greek and Italian ſtates will derive light from what is known of the Gaulic, German, and Scandinavian tribes. The Norwegians, Angles, Saxons, Danes, of the ſeventh, eighth, and ninth centuries, will be found to reſemble the Germans of Cæſar and Tacitus. The conſtitutions of the Anglo-Saxons, Franks, before the feus, Viſigoths, and Norwegians in Iceland, will be found ſimilar, and Denmark, Sweden, Poland, and Hungary, may be expected to retain more of the antient Saxon conſtitution than the preſent Britiſh government.

This eſſay is divided into ſections, in the firſt of which Mr. Maconochie treats *of the government of the German nations, while in their original territories.* From Cæſar and Tacitus he infers, that theſe nations ſojourned in annual huts, and cultivated a ſmall ſpot of ground for ſubſiſtence, in aid of their cattle. They had *pagi* or holds on ſome eminence to retire to in times of danger.

This point of union neceſſarily produced aſſemblies of the warriors, and the election of a chief; which chief, Mr. Machonochie ſuppoſes, was elected for life, and on his death, the office was conferred on a perſon of his family; the chiefs of the tribes were likewiſe elected Each *pagus* was independent, but wars induced them to confederate, and leagues of offence and defence were univerſally formed, and a leader was choſen, whoſe power was to laſt as long as there was uſe for them. Theſe leagues were attended with a diſtribution of the confederates into regular numbers. Thus each pagus came to raiſe a certain number for any enterprize, and each tribe furniſhed its quota; and this ſpecies of arrangement may be found to have exiſted among the Iſraelites, the Tartars, and the ancient ſtates of Greece.

From hence a natural union aroſe, and the common leader in war, in time, retained his power for life; and the combined *pagi,* in time, formed a greater or leſs confederacy, as Tacitus deſcribes the Suevi. From ſuch a general arrangement, we may perceive the nature of their aſſemblies. The chief ſitting in council with the aged, and the warriors forming a circle round all in arms. Attendance on theſe aſſemblies were among the firſt duties of citizens, till government had obtained its energy, and then the kings and magiſtrates have no further occaſion for them. Theſe aſſemblies were held regularly at ſtated times, and on extraordinary occaſions. Here religion and feaſting both were employed, public affairs agitated, and capital crimes tried.

The functions of the chief were in general only miniſterial; while the laws are few, no doubt ariſes reſpecting them; when they became compliated, the chief had recourſe to aſſeſſors and deputies for aſſiſtance; from whence it ariſes, that in almoſt all countries the king is the ſource of judicial procedure. The conſtitutional authority of the German chiefs was not more extenſive in political than in judicial affairs; his power was moſt conſpicuous in military expeditions. This form of government is ſtrongly confirmed by what we know of the form of government in Sweden and Iceland. Small communities elected chiefs; theſe communities combined together under a common leader, and theſe combinations again joining, formed a republic under a chief magiſtrate.

Beſides the general wars undertaken by theſe communities, each private proprietor had the right of waging war with another, and even to acquire the eſtates of his opponents by a ſort of right of conqueſt. As property became conſiderable, each wealthy perſon had his retainers, who were fed and armed at his expence, and became firmly attached to him. This ſtation was not looked on as diſgraceful.

In ſect. II. Mr. Machonochie examines the opinions that feudal tenures and nobility commenced in Germany, which, after a long diſſertation on the proofs exhibited by each party, he determines in the negative.

II. *A Diſſertation to prove that Troy was not taken by the Greeks.*

By JOHN MACLAURIN, *Eſq.*

MR. MACLAURIN firſt ſets out with aſſerting, that the Greeks were unacquainted with writing at the time of the Trojan war, and that the tablets mentioned by Homer, contained only marks or ſigns, and that the Greek writers had therefore an opportunity to relate things as they pleaſed. He mentions ſome circumſtances, in which they did ſo; and concludes that Homer took that liberty. He alſo contends, from a paſſage of Thucydides, and ſome in Homer, that the poet did not live ſo near the event he recites, as is generally aſſerted. Many of the ancients alſo, he ſays, diſbelieved Homer's ſtory, and thought that Helen was not a real, but an allegorical perſonage. That Herodotus contradicts facts aſſerted by Homer, and that Thucydides doubted if any credit ſhould be given to the poems.

Having laid down theſe premiſes, Mr. Maclaurin endeavours to ſhew, that the account given by the Greeks of the Trojan war is improbable; and that if even there was a Trojan war, Troy was not taken by them. The arguments he uſes are, he confeſſes, taken from the diſſertations of a Greek author, Dio Chryſoſtemos, who wrote two diſſertations on Homer; in the firſt he makes his panegyric as a poet, and in the ſecond takes him to taſk as an hiſtorian. This latter may be divided into two parts; in the firſt he gives an account of the Trojan war quite oppoſite from that of Homer; and in the other he attempts to prove, that Homer's account is falſe, abſurd, and contradictory. As Mr. Maclaurin obſerves, it is a matter of indifference to us whether the Greeks or Trojans prevailed, we ſhall therefore not enter further into a paper which cannot be abridged.

III. *An Ode on the Popular Superſtitions of the Highlands of Scotland. By the late Mr.* William Collins.

THIS ode is preceded by two letters, one from Mr. Tytler, who thinks that this ode is the ſame as was mentioned by Johnſon, in his life of Collins, and that being found imperfect, the fifth and part of the ſixth ſtanzas were ſupplied by Mr. W. Mackenzie of the Exchequer.

The other letter is from Dr. Carlyle to Mr. Tytler, aſſerting the authenticity of the MS. which he ſays is in Collins's hand writing.

IV. *An Eſſay upon the Principles of Hiſtorical Compoſition, with an Application of thoſe Principles to the Writings of Tacitus. By* John Hill, *M. A. F. R. S. Edin. and Profeſſor of Humanity in the Univerſity of Edinburgh.*

FOR the purpoſe of eſtabliſhing a canon for judging of the merit of a hiſtorian, the writer conſiders thoſe qualities which ought to predominate in his character, under the heads of *Feeling*, *Imagination*, and *Judgment*.

Feeling, or the ſenſibility to impreſſions, may be exceſſive or deficient. The latter is the moſt frequent fault, for a high degree of delicate perception is neceſſary to enable the hiſtorian to ſhine in deſcription and moral ſentiment. He muſt further, have a quick ſenſe not only of things which exiſt, but of thoſe which are ideal, or a lively *imagination*. This gives him the power of imitating the true language and colour of the ſcenes he deſcribes, and of adorning his ſtyle by apt and forcible figures. *Judgment* is ſupremely neceſſary for the regulation of the other two qualities, and alſo to give him the requiſites of clear arrangement and choice of matter, of impartiality, and of ſagacity in pointing out cauſes and effects, and drawing concluſions.

Having eſtabliſhed theſe qualities as a ſtandard, the writer proceeds to apply it to the works of Tacitus. The ſenſibility of this author appears in many ſtriking paſſages, of which Mr. Hill inſtances, the death-bed ſcene of Germanicus, the voyage home and landing of Agrippina, the death of Otho, the trial of Ioranus, the behaviour of Hortalus, and his own moral reflections on certain occaſions. In the uſe of figures he is ſparing, but happy. His ſimilies in particular have much force and propriety. His talents for fine deſcription are diſplayed in numerous inſtances; ſuch as the account of the plague at Rome, the ſufferings of Octavia, the diſtreſs of the deſerted Vitellius, &c.

In the ſecond part of this paper (No. VIII.) the writer reſumes his ſubject with conſidering the *judgment* of this celebrated hiſtorian. His works are all important, and exhibit a talent for clearneſs of arrangement. His impartiality diſcovers freedom from prejudice; and his obſervations ſhow the utmoſt penetration into the characters of men, and the cauſes of things. Of theſe, a variety of inſtances are adduced by Mr. Hill. Such are the excellencies of this hiſtorian; but he is not without his faults. His ſtyle has been juſtly condemned as harſh and abrupt, but Mr. Hill is not of opinion that he made Salluſt his model. He vindicates him againſt the charges of being oſtentatious of his learning, and inconſiſtent in his deſcriptions of characters; but he acknowledges an occaſional fondneſs for conceits and quaintneſſes. There are alſo, in his language, many uſes of words deviating from the beſt authorities in the purer age of Latinity, of which Mr. Hill gives ſeveral examples, particularly with reſpect to the particles *alias*, *an*, *et*, *penes*, concerning the proper meaning of which he treats at ſome length.

V. *On the Dramatic or ancient Form of Hiſtorical Compoſition. By* WILLIAM RICHARDSON, *M. A. F. R. S. Edin. and Profeſſor of Humanity in the Univerſity of Glaſgow.*

BY the *dramatic form* of hiſtorical compoſition, the writer means that mixture of ſpeeches ſuppoſed to be delivered by eminent perſons, which is interwoven with the narration in ancient hiſtories. This mode he ſuppoſes to have been originally adopted, not from critical preference, but in conſequence of the ſimple imitation of real action. The ſpeeches were at firſt ſhort and colloquial, but in proceſs of time became pieces of elaborate oratory, which, however, the cuſtom in the Greek and Roman ſtates, of employing public ſpeaking on all great occaſions, rendered natural. It cannot be denied that this method of writing has the advantage of being more animated and entertaining than continued narrative; but it is objected to on account of its violation of truth; ſince moſt of the ſpeeches ſo introduced could not have been thoſe of the perſons attributed to them, if they ſpoke at all. To this objection, Mr. Richardſon replies, 1*ſt*, That in moſt of the caſes, ſpeeches may be ſuppoſed to have been really made, and if their ſubſtance came to the knowledge of the hiſtorian, it was his buſineſs to relate it; and in what manner could he do this better, than by putting the matter into the mouth of the ſpeaker? 2*dly*, Were the caſe otherwiſe, the rules of ſtrict veracity are as much violated by hiſtorians in other inſtances; as when they endeavour to explore the ſecret cauſes of actions, and impute views and motives to men, which it is impoſſible they ſhould know any thing of, more than by mere conjecture.

But though Mr. Richardſon thus defends the practice of the ancient hiſtorians, he does not mean to propoſe it for imitation to the moderns, in whom it would be leſs ſupported by probability: beſides that it ſuited better the oratorical ſtyle of hiſtory adopted by the former, than it would the philoſophical form aſſumed by the latter.

VI. *A Grammatical Eſſay on the Nature, Import, and Effect, of certain Conjunctions, particularly the Greek* ΔΕ. *By* JOHN HUNTER, *M. A. F. R. S. Edin. and Profeſſor of Humanity in the Univerſity of St. Andrews.*

THE writer begins with an obſervation of the unphiloſophical nature of the uſual mode of arranging words under the different parts of ſpeech, inſtancing the word *after*, which if put before *he departed* would be called a conjunction, but before *his departure* a prepoſition; when its meaning is preciſely the ſame in both.

He then offers a conjecture concerning the Engliſh prepoſition *to*, one of the ſpecial applications of which is, to mark *addition*. Thus, in theſe lines of Denham,

> Wiſdom he has, and *to* his wiſdom, courage;
> Temper *to* all, and, un*to* all, ſucceſs.

Here,

Here, all the ſucceeding circumſtances are marked as additions to the preceding. But he might with equal propriety have ſaid,

> Wiſdom he has, and courage *too*, &c.

In this caſe, the difference is only that the object governed by *to* is not formally expreſſed, but is underſtood; and not only a noun ſubſtantive may be thus omitted, but a clauſe of a ſentence involving a propoſition. Thus,

> ——— Let thoſe eyes that view
> The daring crime, behold the vengeance *too*;

in which example, the circumſtance of *beholding the vengeance* is ſtated as *additional* to that of *viewing* the crime. But though all theſe uſes of the word *to* are really one and the ſame, grammarians have claſſed *to* in the firſt caſe among the prepoſitions, and in the latter among the conjunctions and adverbs; and hence a difference of orthography has ariſen between *to* and *too*, which however did not exiſt in the Saxon, or even in the Engliſh, previouſly to the reign of Elizabeth, when what we now ſpell *too* was written with a ſingle o.

The Latin language affords a ſimilar example in the prepoſition *ad*, one of the ſpecial applications of which is to mark *addition*. Thus, "*Ad* hoc, promiſſa barba et capilli efferaverant ſpeciem oris." But the object governed by *ad*, is often not formally ſtated, in which caſe, like the Engliſh *to*, it is claſſed with the conjunctions, and written *at*. Thus, "Cæſar Dumnorigem cepit, *at*que interfecit." It has ſometimes the ſame meaning without *que* ſubjoined. Thus in Terence---"*Ph.* Fac, ita ut juſſi, deducantur iſti. *Pa.* Faciam. *Ph.* At diligenter. *Pa.* Fiet. *Ph.* At mature." Here the circumſtances of *diligence* and *haſte* are *ſuperadded* to the action commanded. Another of its ſpecial applications is to mark one object as *united* or *joined* to another, and this, whether the objects be ſuch as are *commonly* joined, or the union of which appears *incongruous*. Of the firſt kind is this from Livy: "*Ad* imperium dictatoris, cuncta mota acies;" *joined to* the command of the dictator, &c. i. e. *at* the command. Of the ſecond is the following: "*Ad* imperium dictatoris, diſcedere nolebant;" joined *even to* the command, &c. i. e. *even at* the command.

It is in this laſt manner, viz. *to mark the unexpected union of incongruous objects*, that *ad*, when the object which it governs is not formally ſtated, i. e. *at*, the conjunction, is commonly applied; as "Aulam tyranni frequentabat, *at* patriam amabat," where, by means of *at*, the circumſtance of *loving his country* is ſtated as *united* to that of *frequenting the court of the tyrant*, to which it ſeems in ſome meaſure oppoſed. Of this union *at* appears to be the ſymbol; though by the habit of annexing an emphatical meaning to it, as raiſing an expectation of *incongruity* in the things united, it has come to be miſtaken for a ſymbol of *oppoſition*, and hence has been called an *adverſative*. This appears from the ſimilar uſe of ſuch words as *etſi*, *tamen*, *cependant*, *at the ſame time*, *notwithſtanding*, which intimate the *co-exiſtence* of things which are generally ſuppoſed to prevent or oppoſe the exiſtence of each other.

The writer proceeds to conſider whether light may not be thrown on the nature of the Greek particle δε by theſe remarks. It is frequently found after the accuſative caſe of nouns common and proper, ſingular and plural; as, Ιλιονδε, αγορηνδε, οικαδε. Here it is applied to the place to which real motion tends; but it is alſo applied to any object to which an action is directed as its final cauſe; as, Μη αγορευε φοβονδε---literally, Do not ſpeak *to* flight. In theſe caſes, δε may be conſidered as a prepoſition put after the word, and equivalent to *ad* or *to*. On this hypotheſis it is reaſonable to imagine, *1ſt*, That it may be uſed in the ſpecial meanings of *added to*, *joined to*; and *2dly*, That the object governed by it may be not formally ſtated, but left to be collected from a preceding noun and prepoſition; in ſhort, that it ſhould have the ſame application as *ad* and *to*, when called conjunctions. This is the caſe in fact; as when Ulyſſes enumerates to Achilles the preſents intended for him, he ſays,

> ‘Επτ’ απυρους τριποδας, δεκα ΔΕ χρυσοιο ταλαντα,
> Αιθωνας ΔΕ λεβητας εεικοσι, δωδεκα Δ’ ἱππους.

Here, by means of δε, each ſucceeding article is repreſented as *additional to* the preceding; exactly ſimilar to the uſe of *to* in the lines formerly quoted from Denham. Many inſtances of the like kind are to be found in all the Greek authors. But δε is often ſaid to denote *oppoſition*, which in reality it never does, but only, like the Latin *at*, unites what may appear oppoſite. In this caſe, as Hoogeveen has obſerved, the oppoſition is in the propoſitions, not in the particle δε, which connects them. Even when oppoſition ſeems the moſt ſtrongly marked, it may be reſolved into an union of apparently incongruous objects; as when, in Euripides, Oreſtes ſays,

> Ονομα γαρ, εργον ΔΕ ουκ εχουσιν ὁι φιλοι,
> ‘Οι μη επι ταισι συμφοραις οντες φιλοι,

it may be literally rendered, For the friends that are not friends in adverſity, have the name of friends, not the reality *too*. Nomen, *at* non rem habent. It ſhould ſeem, then, that the conjunction δε, even when it is ſaid to mark oppoſition, and tranſlated *but*, ſtill retains its genuine ſignification of *union*; with this variation, that in ſuch inſtances it ought to have the force, not of *to* ſimply, but of *to* with emphaſis, or *even to*. But δε, when in the form of a prepoſition governing the accuſative, is not accented; whereas δε the conjunction is always accented: whence Hoogeveen has been led to conſider them as of different origin. But the analogy of *to* and *too*, the firſt uſed when the object is expreſſed, the other when it is not expreſſed, may hold with reſpect to the two uſes of δε.

The writer concludes his paper with the following concluſions derived from it:

1ſt, That *prepoſitions*, in various languages, govern not only nouns ſubſtantive, but alſo clauſes of ſentences bearing the form of propoſitions; but that ſuch clauſes are then equal to nouns in their *effect*, the *abſtract amount* of them only being regarded: and, conſequently, that, by this *ſeeming* change of their regimen, no *real* change is made, either in the grammatical nature, or in the ſignification of the prepoſitions themſelves.

2dly, That, whether the object governed be a noun ſubſtantive, or the amount of a propoſition taken as a noun ſubſtantive, that object is often not formally ſtated, being obvious from the context; but that neither does the *formal ſtatement*, or the *omiſſion* of the governed object, make any change, either in the grammatical nature, or in the ſignification of the prepoſitions.

3dly, That the ſpecialities attending theſe *prepoſitions*, when they are called *conjunctions*, depend, in as far as the *expreſſion* is concerned, on one or other, or both of the following circumſtances, viz. the governed objects *being involved in a propoſition*, or its *not being formally ſtated.*

4thly, That the adverſative *appearance* of *ſome* of the conjunctions called *adverſative*, ariſes ſolely from the *emphatic* meaning given to them, when employed to mark the union of objects *ſeemingly* oppoſite or incongruous; but that, though they may *preſuppoſe*, they do not *expreſs* ſuch incongruity or apparent oppoſition.

5thly, By having ſhewn that the conjunctions *too*, *at*, and δὲ, are the ſame with the prepoſitions *to*, *ad*, and δὲ, we have diſcovered their ſtrict and proper ſignification, and are thereby enabled to annex to each of them a *preciſe idea*, inſtead of having a vague and confuſed *feeling* of their *effect*.

Laſtly, By having aſcertained the grammatical nature of *certain* conjunctions, we have advanced *one* ſtep towards the developement of *conjunction* itſelf---I mean the *part of ſpeech* ſo called---which is ſtill a *deſideratum* in grammar, the nature of it being, perhaps, leſs underſtood than that of any other of the parts of ſpeech.

VII. *Eſſay on the Origin and Structure of European Legiſlatures.* *By* Allan Maconochie, *Eſq.*

PART II.

Section I. *Of the Legiſlature of the German Nations after their Eſtabliſhment in the Roman Provinces.*

MR. MACONOCHIE thinks, that after the cloſe of an expedition, the leader of a German confederacy did not immediately lay down his office. The confederate tribes would alſo adhere to their ancient habits. The conquered country would be parcelled among them, and their old military and religious ceremonies continued. This would be rendered neceſſary to ſupport themſelves againſt the conquerors, to whom in numbers they would be inferior. It would be likewiſe neceſſary to have a general muſter yearly of the whole confederacy, and to attribute to their king or general, the right of calling forth the nation in arms, and of enforcing the regulations made by common conſent. In theſe general muſters the national affairs would be tranſacted. The power exerciſed by the king would be founded in the influence of his old retainers, and in the habits of the vanquiſhed natives; from the latter ſource the forms of official buſineſs would retain the language of deſpotiſm; the imperial fiſcs would remain with the king, and the right of diſtributing lands, from whence he would become the chief proprietor in the nation. He would be able to multiply his retainers, and the ſubordinate chiefs would likewiſe be enabled to multiply theirs. Some of theſe lands were transferred in full property, others on terms of military ſervice; theſe latter were termed benefices.

Mr. Maconochie does not apprehend that the acquiſition of the Roman towns, or the embracing of Chriſtianity, would make any innovation in the form of the German legiſlature; the municipia would acquire the aſpect of German *pagi*. The chiefs of the Chriſtian clergy acquired a ſhare in the rank, by ſharing in the functions of their chief.

By this hypotheſis, the diets of the European ſtates were originally national aſſemblies, conſiſting of the whole warriors, conducted by the local chiefs, who, together with the king and clergy, formed a ſenate or council. Mr. Maconochie traces the origin of theſe diets in France, in Spain, and in Britain; and concludes, that in the latter country, the freeholders were originally members of the legiſlature: and that all freeholders owed military ſervice.

Section

SECTION II. *Of the deliberative Body in the Anglo-Saxon and Scottiſh Diets, and whether they contained Repreſentatives from the Towns.*

Mr. Maconochie ſuppoſes that the diet conſiſted of two bodies, and that the *ſapientes natu majores*, were the magiſtrates; and after a long examination concludes, that the towns enjoyed no peculiar ſyſtem of adminiſtration, till, by becoming wealthy and formidable, they were enabled to aſſiſt the ſovereign, and to obtain from him privileges in return.

Letters and Papers on Agriculture, Planting, &c. ſelected from the Correſpondence of the Bath and Weſt of England Society for the Encouragement of Agriculture, Arts, Manufactures, and Commerce. Vol. VI. 1792.

I. *A Series of Letters on Planting and the Management of Woods, from* T. SOUTH, *Eſq.*

THE firſt letter relates chiefly to Oak Timber, and its ſubſtitutes. The preſent decreaſe of it is lamented, and growers are adviſed in what caſes to rear it ſtraight, and in what crooked. The crooks and knees of oak are peculiarly valuable for naval purpoſes, and a certain proportion of them is always required in the navy contracts. The letter concludes with an account of an oak felled in 1758, in Langley Wood, on the verge of the New Foreſt, the timber of which amounted to 28 tons.

Letter II. is on the growth of Elms. This tree delights in a rich black mould, and requires free room to ſpread its roots. The moſt profitable mode of planting it is in hedge-rows. After ſome deſcriptions of particular trees, and of the ſucceſs of ſome plantations, the following obſervations and concluſions are drawn.

1ſt, As the growth of Elm bears proportion to the extent of ground allotted for its roots to range in; thoſe who would propagate large timber, muſt never plant too cloſe.

2dly, That though branchy elms are the quickeſt growers*, they are not the moſt profitable to the planter; for ſuch timber is little ſought after, and one branch only being accepted by the merchant as timber, the reſt all go with the top, which reduces the contents exceedingly.

3dly, That as the value of this timber conſiſts more in length and bulk of the ſhaft, than in the crooks and contents of its branches, it is the buſineſs of planters to train them up tall and ſtraight, to keep their ſhafts clean, and not to ſuffer them to branch till within a few feet of the top.

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* That branchy trees are the quickeſt growers, I believe to be invariably the caſe, and may be thus accounted for; the ſap imbibed by the roots, is a compound of aqueous and nutritious matter; the quicker it is in its paſſage, the greater is the demand upon the roots, which extend themſelves accordingly in ſearch of freſh ſupplies; the branches follow their direction, and ſtill increaſe the demand; ſo that the more branches a tree has, and the nearer they are to the ground, the ſooner the ſap perſpires off its aqueous particles, depoſiting the nutritious ones by the way. Wherefore the timber is more amply fed by an accelerated current of ſap, than by a tardy one, conſequently branchy timber increaſes more in proportion, than that which is clean ſhafted, where the ſap is longer in its progreſs, finding no outlet till it reaches the top.

4thly, The preſent method of lopping, though conducive to the lengthening of the ſhaft, fills it full of rough protuberances, which by admitting water, are very prejudicial to the timber, and occaſion the defects ſo generally complained of.

5thly, The ſhaft of the elm advances inch by inch through its whole contents, that is, every inch lengthens yearly; by this means it advances more or leſs in proportion to its length, beſides the addition of new wood at the top; ſo that a branch now thirty feet from the ground, will (in a growing ſtick) five years hence be removed higher by a foot, conſequently the timber is increaſing in length beneath that branch, as well as above it.

Laſtly, The growth of elm is to that of oak, in a hazely loam like mine, as three to two, and the value of the timber, if long and ſtraight, as two to three. The profits of the planter, therefore, both in oak and elm, will be nearly on an equality.

To train up Elms to long ſtraight Shafts.

Care muſt be taken in planting, to ſhorten all the ſide-ſhoots, and leave the leading ſhoot intire.

In three or four years afterwards, cut the lowermoſt of the ſhortened ſhoots clean off, and ſhorten moſt of the maiden ſhoots above them, carefully preſerving the leading ſhoot, and prevent its having a competitor; at Midſummer following, ſtrip off all ſuch ſprays as have put forth from the ſides of the wounds (by hand.)

Proceed in the ſame manner every three or four years, cleanſing about four feet of the ſtem at a time, ſhortening the upper branches, cutting off cloſe thoſe which were ſhortened at the preceding trimming, and ſtripping afreſh at Midſummer, till thirty or forty feet of ſhaft is obtained without ſpray or blemiſh; they may then be left to themſelves, for the ſhaft will lengthen ſome feet, and ſhould they put out more ſprays from the lips of the old wounds, ſuch may be ſtripped off by hand, from time to time, till this vicious inclination ceaſes. Beautiful and valuable timber will be thus obtained at a very trifling expence, which the pea-ſticks that come off will nearly defray.

The advantage that ariſes from ſhortening ſome of the maiden ſhoots at every trimming, conſiſts in checking their growth; which cauſes them to be ſmall at the baſe, in proportion to the bole of the tree*; conſequently the wounds are but trifling, ſome heal over, and the bark becomes ſmooth. It is adviſeable to prevent theſe trees from forking at the top as long as poſſible, for they are very apt to break off at the forks which injures the timber.

Letter III. Abele wood, not being ſubject to the worm when kept from wet, anſwers well in building. They are ſubject to warty excreſcences, which, when large, bring on decay. Alder is of little value as timber, but is very ornamental in wet ſituations. Aſh is valuable when properly managed and in good dry ſituations. If removed when ten or twelve feet high, the grain acquires a tenacity very prejudicial to the timber. Beech is a free grower, and applicable to many uſeful purpoſes. It is peculiarly excellent in water-works. It delights in chalky ſoils and lofty ſituations. Scotch fir, though not equal to Baltic deal, is worth propagating for ordinary purpoſes. The drier the ſituation on which it is planted, the ſlower its growth, but the more valuable its timber.

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* I ſcarce need ſay that bole and ſhaft are ſynonymous terms.

Letter IV. Deſcription of Fyfields Oak, now ſtanding in a wood near Romſey in Hampſhire.—In this is introduced a ſketch of the progreſs of an oak during the latter half of its exiſtence, in order to ſhow that it will pay good intereſt for ſtanding till it arrives at maturity. It concludes with an account of the Bull Oak, a large decayed tree in Wedgenock Park, Warwickſhire.

Letter V. An Eſſay on the Growth of Oaks, and on the production of Crooked Timber for naval purpoſes.—The growth of middle-aged oak is generally from one inch 1-third, to an inch in circumference yearly; between its twentieth and its hundredth year, it ſometimes exceeds this meaſure; and in its ſecond century falls within it. But as the ſolidity of the ſhaft conſiſts leſs in its length, than in the ſquare of its diameter in the girting place, a ſmall addition to the diameter there enlarges the ſquare abundantly. Wherefore, though the circumference from the hundredth to the hundred and fiftieth year, may not increaſe ſo faſt as it did to the hundredth, the ſolid contents will be increaſing faſter; for as the ſquare of the diameter* 40 = 1600 exceeds the ſquare of 24 = 576†, ſo will the contents in the 150th year exceed the contents in the 100th, when its annual enlargement was 1-8th of an inch greater.

Tall ſtraight oaks, when of full ſize, are beautiful objects, whether ſingle or in woods. They are requiſite for beams, for kelſons, ſtern-poſts and plank-ſtocks; and great is the conſumption of the latter; for ſhips are planked both within and without with oak, ſave beneath the light water-line, where beech performs that office. The growth of oaks like theſe is the chief aim of the generality of planters; and ſeems to have been the immediate deſign of the ſurveyors of Dean Foreſt. Should their plan be adopted, the trees will draw one another up ſo faſt, that ſcarce a crooked one will be found in 18 thouſand acres, ſave round the out-ſkirts; and the ſoil will be full of ſtubs, which, as oak robs oak, muſt check the growth of the ſurviving timber.

Mr. S. takes his hint for the production of crooks and knees, from what is obſerved in a foreſt, of timber trees being accidentally reared under thorns and buſhes. Theſe protect the young plants, and afford them manure. He propoſes that it ſhould be imitated by ſowing acorns deſignedly under quickſets and coppices. The mode in which crooks are naturally formed is illuſtrated by plates, repreſenting trees forced out of the perpendicular by others. Trees growing on a bank alſo frequently take a favourable turn in the thickeſt part of the butt, and he recommends planting ſome oaks in that ſituation.

Additional Letter to the Secretary. This announces an intended work of the ſame gentleman, on the culture of peaches and nectarines, for which fruits he ſeems to thinks the climate of England as favourable as any other, or perhaps more ſo. The work is alſo to contain a regular ſyſtem for pruning and managing wall-trees in general.

II. *A*

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* Forty inches was the diameter of Fyfields Oak, in its 150th year, - - 40
×40
1600 = Its ſquare.

† Twenty-four inches diameter of the ſame in its 100th year, - - 24
×24
576 = Its ſquare.

II. *A Deſcription of the Inſtrument called a Sward-Cutter, invented by the Hon.* Robert Sandilands *ſome Time ago, now much improved, particularly with Regard to the Expence, it being reduced from* 15 *or* 16*l.* *to* 5 *or* 6*l.*

PLATE XI. Fig. 4. No. 1. A A, &c. a ſquare frame three feet four inches from the fore to the hind part, by four feet three inches, the breadth of the machine within ſide; the timber (when of fir) four inches ſquare, placed on two wheels B B, three feet diameter, a little more or leſs, (the old fore-wheels of a chaiſe may anſwer the purpoſe to ſupport the hind part of the machine.

C C, &c. ſix ſtrong pieces of wood, called bulls, three feet long, five inches and a half broad, the thickneſs ſix inches at E, No. 2, and tapering to 3 inches at F. Into theſe bulls are fixed the cutting wheels, which are iron, 13 inches diameter, three quarters of an inch thick at the centre, about an inch diameter, for piercing holes to fix the iron axles in; from that they are to be of ſuch thickneſs, as to allow the edges to be well ſteeled. Theſe wheels are fixed by two bolts going through the bulls, with eyes on one end, for the axles of the wheels to run in, and nuts and ſcrews on the other, to make them very firm by, and ſunk in the bulls, to prevent their interfering with the weights L reſting on them.

G G, in No. 1, are hollow pieces of wood called *thorles*, each three inches and a half long, which incloſe the bolt M, and keep the bulls C C at their proper diſtances, but may be made longer or ſhorter at pleaſure, as the ward requires to be cut in larger or ſmaller pieces. They are in two pieces, and bound together, and jointed by a ſtrap of leather or cord, which allows them to be readily changed, when the cutting wheels require to be kept at more or leſs diſtance.

The iron bolt, No. 1, goes through two pieces of wood or iron, ſeven inches long, clear of the wood, ſupported by iron ſtays, fixed to the frame, and through all the bulls, as at T, No. 3, it requires to be ſtrong, as the draught of the horſes terminate there.

H H, No. 2 and 3, a cylinder or ſegment of wood, ſeven inches diameter, called a *rocking-tree*, which goes acroſs the frame, and moves on the pivots fixed into it, one at each end, ſupported by an iron bolt, or piece of wood morticed into the frame, eight inches high, as appears in No. 2 and 3, to which ſix chains or ropes are fixed by hooks, at different diſtances, as you want your cuts, at 9, 8, 7, or 6 inches from one another, and are joined to the end of each bull, in which the cutting wheels run; ſo that when the rocking tree is turned about by the lever I, fixed in the middle of it, all the bulls, with their cutting wheels, are raiſed out of the ground at once, as in No. 3, by which means the machine may be turned, or moved from place to place with great eaſe, without any danger of ſtraining the wheels.

N. B. The rocking-tree is not delineated in No. 1, in order that the plan of the frame may be more eaſily underſtood.

L L, No. 1, 2, 3, are weights of free ſtone, 26 inches long, ſix inches broad, the under one four inches thick, the upper one of the ſame dimenſions, and three inches thick, which will weigh (according to the gravity of the ſtone) about four ſtone the under, and three the upper, all of them having two holes in them, through which iron ſpikes, firmly fixed in the bulls, paſs, in order to keep them ſteady.

When the ground is eaſily cut, the under ſtone, of four ſtone weight may anſwer; when more difficult, the other ſtone of three ſtone weight may be added, ſo that every wheel may have ſeven ſtone weight upon it, which has been found ſufficient for the ſtiffeſt land and tougheſt ſward the machine has ever been tried on. Caſt iron weights will anſwer fully better, but are more expenſive, which the inventor wiſhes by all means to avoid.

The lever I, No. 2, 3, which ought to be five feet long, muſt have a ſliding rope on it, fixed to the back part of the frame, ſo that when the cutting wheels are all taken out of the ground three or four inches, by the rocking tree's being turned partly round by the lever, the rope is then fixed to it, by putting a loop at the end of the rope over the pin R, No. 3, (it ought to be placed three feet four inches from the extremity of the lever I,) which keeps all the cutting wheels out of the ground till the machine is turned, and then, by moving the loop of the pin, it ſlips back towards the frame, and the lever is gently let back to its place, as in No. 2, by which the cutting wheels are put into their former poſture, by the weights fixed on the bulls in which they run. The levers may be made of good tough aſh.

P, No. 1, a ſmall bolt of iron, with a hook on one end of it, (one is ſufficient) to ſtrengthen the bolt M, to be hooked on the centre of it, and joined to the frame by a nut and ſcrew.

The grooves, in which the cutting wheels run, may be covered below at the hinder part with a plate of thin black iron, ſix inches long, three inches broad, having a ſlit in it where the wheels run, to prevent (if found neceſſary) any graſs, weeds, or ſmall ſtones, from filling the grooves, and clogging the wheels; the form of which is ſeen at the letter *i*.

To the frame, as ſeen at No. 1, are fixed (for a double-horſe ſward-cutter) three ſhafts, as in a waggon, of ſuch length, ſtrength, and diſtance from one another, as any workman may think proper.

For a ſingle-horſe ſward-cutter (which has only four cutting wheels) a pair of ſhafts are uſed, and may make the two ſides of the frame without any joinings. The width of the frame, in proportion to the double-horſe ſward-cutter, is as four to ſix.

It is recommended for a double-horſe ſward-cutter to have eight bulls and wheels, that when it is uſed to reduce hard cloddy ſummer fallow, or land for barley, before the laſt furrow, or even after it, the whole weight, 42 ſtone, employed in ſward-cutting the ſtiffeſt land and tougheſt ſward, may be applied to the eight bulls then at ſix inches from one another: the four ſtone weights to be applied to ſix of the bulls, and two of the three ſtone weights to each of the additional bulls, which it is thought will prove a ſufficient weight for the purpoſe, and will effectually prevent a clod, at any time, of more than ſix inches broad, from eſcaping being broke to pieces.

In the ſame manner, a ſingle-horſe ſward-cutter may have ſix bulls for the above-mentioned purpoſe; the 28 ſtone belonging to it divided thus: the four ſtone weights to four of the bulls, and two of the three ſtone weights to each of the additional bulls. It was thought better to be rather minute here, than trouble the perſon employed in uſing the ſward-cutter with any calculations.

That the inſtrument may come as cheap as poſſible to the public, the inventor is of opinion, that the expence of the two wheels and the iron axle (which is conſiderable) may be ſaved, by joining ſtrongly to the frame at S, No. 3, a piece of wood with a little curve at the extremity of it, reſembling the foot of a ſledge, formerly much uſed in Scotland, to carry in the corn from the field; the part of it reſting on the ground being kept 18 inches (the half diameter of the wheels) from the frame, by a ſtrong ſupport of wood.

As the two outer bulls next the frame are apt to get under it, ſo as to prevent the cutting wheels from being taken out of the ground, a thin ſlip of iron fixed to the inſide of the frame, nearly oppoſite to the back end of the bulls, of convenient length, will be found neceſſary.

A ſhort Account of the Uſes of the Inſtrument called a Sward-cutter, with the Advantages attending it, and the Manner of uſing it.

The original intention of this machine was to prepare old graſs ground for the plough, by cutting it acroſs the ridges, in the beginning of, or during winter, when the ground is ſoft, in order to anſwer all the purpoſes that Mr. Tull propoſed by his four-coulter plough, ſo ſtrongly recommended by him for bringing graſs ground that has been long reſted into tilth. This the ſward-cutter has been found to do, much more effectually and expeditiouſly, as Mr. Tull's plough, with four coulters, cut the ſward in the ſame direction with the plough, and is liable, from every ſtone, or other obſtruction any of the coulters meet with, to be thrown out of its work altogether, or the inſtrument broke, to which the ſward-cutter, conſiſting of four, ſix, or more cutting wheels, is never liable, from their being entirely independent of one another, cutting the ground acroſs the ridges before plowing, and rendering that operation eaſier to two horſes than it would be to three without its being cut. The furrow being cut acroſs, falls finely from the plough in ſquares of any ſize required, not under ſix inches, in place of long ſlips of tough ſward, ſeldom and imperfectly broke by the four-coultered plough.

Any perſon who reads Mr. Tull's deſcription of his four-coultered plough, and what he propoſed by it, will ſoon ſee the great advantage the ſward-cutter has over it, in producing the deſired effect of bringing old reſted graſs ground into tilth; an object univerſally allowed to be of no ſmall importance to agriculture.

This inſtrument is very fit for preparing ground for burnbating, as it will ſave much hand labour.

It may be properly uſed in croſs-cutting clover, of one or two years ſtanding, to prepare the ground for wheat, if the land be ſtiff and moiſt enough.

It may be applied to cutting and croſs-cutting paſture ground, intended to have manure of any kind put upon it to meliorate the graſs. In this it will far exceed the ſcarificator mentioned in one of Mr. Young's tours, as that inſtrument is liable, as well as the four-coultered plough, to be thrown out of its work when meeting with a ſtone or other interruption. This the ſward-cutter is proof againſt, which is looked on as its greateſt excellence.

In preparing for barley, the ſward-cutter excels a roller of any kind, in reducing the large hard clods in clay land, occaſioned by a ſudden drought, after its being plowed too wet; and it is likewiſe very proper for reducing ſuch clay land, when under a ſummer fallow. In this operation the ſward-cutter is greatly to be preferred to the cutting roller, likewiſe mentioned by Mr. Young in one of his tours, from its wheels being all dependent one on another, ſo that when one is thrown out by a ſtone, three or four muſt ſhare the ſame fate: beſides, the cutting roller has but ſeven wheels in ſix feet, and the ſward-cutter has ſix in four feet three inches, at nine inches diſtant; and, if neceſſary, may have them ſo near as ſix inches.

After old graſs ground is cut croſs with the ſward-cutter, and plowed, it has a very uncommon and worklike appearance, from each ſquare turned over by the plough, being raiſed up an inch or two at the ſide laſt moved by the earth-board; ſo that the field, when finiſhed, is all prettily waved, and reſembles a piece of water when blown on by a gentle breeze. By this means a very great deal of the land's ſurface is expoſed to the froſt, and other influences of the air, which cannot fail to have a good effect on it.

Two horſes are ſufficient for the draught of a double-horſe ſward-cutter, and one horſe for a ſingle-horſe one; one man manages the machine and drives the horſes. He begins his operation by firſt meaſuring off twenty or thirty paces from the machine, leſs or more, as he inclines, and there fixes a pole. He then cuts the field croſs, as near at right angles with the ridges as he can. When the cutting wheels are paſt the laſt furrow about a yard or ſo, and the machine is upon the utmoſt ridge of the field on which it muſt turn, he muſt ſtop the horſes, then take hold of the lever I, fig. I., No. 2, and by pulling it to him, he raiſes the cutting wheels out of the ground, which are kept ſo by the loop of the rope being put over the pin R. in the lever I, No. 3, till the machine is turned and brought to its proper place, which is done by meaſuring off the ſame diſtance formerly done on the oppoſite ſide of the field. When the cutting wheels are exactly over the outmoſt furrow, then, on the horſes being ſtopped, ſlipt off the pin R, and the lever returned to its former place, as repreſented No. 2, which allows the weights L L, &c. to force the cutting wheels into the ground again. He then goes on till the interval between the firſt and ſecond ſtroke of the machine is all cut. In this manner the field is to be finiſhed, after which you may begin to plow when you pleaſe.——N. B. There muſt be a pole at each ſide of the field.

It is of no conſequence whether the land to be ſward-cut is in crooked ridges, or ſtraight in flat ridges, or in very high-raiſed ridges; ſuch as are frequently met with in Scotland. Be the ſurface ever ſo uneven, it does not ſignify, as the cutting wheels being all independent of one another, are forced by their weights into every furrow or hollow.

One ſward-cutter will cut as much in one day as ſix ploughs will plow.

The land may lie ſeveral months in winter after being ſward-cut, when there is no vegetation to make the cuts grow together again before it is plowed; but the ſooner it is plowed after cutting the better, that it may have the benefit of all the winter's froſt, which makes it harrow better and eaſier at ſeed time.

When the ground is harrowed, the harrows ought to go with the waves that appear after plowing, not againſt them, as by that means they are leſs apt to tear up the furrows all cut into ſquares. This need only be attended reſpecting the firſt two tines, as they are called, of the harrowing.

Any common wright and ſmith may make the inſtrument. It is very ſtrong, very ſimple, and eaſily managed, and moved from place to place; and if put under cover, will laſt many years.

Fig. II, is the plan of a harrow invented by Mr. Sandilands, which he recommends in a particular manner, and to which he has given the name of the *chain and ſcrew harrow*. Its properties are, that if your ridges are high, and you wiſh to harrow them from one end to the other, by lengthening the chain (which the ſcrew commands)

mands) the harrow, when drawn along, forms an angle downwards, and miſſes none of the curve of the ridge, ſo far as it extends, vhich may be nine feet, the diſtance from A to B. The diſtance from C to D is five feet ſix inches. When the crowns of the ridges have got what is thought ſufficient harrowing lengthwiſe, you ſhorten the chain by the ſcrew, which forms an angle upwards; the harrow is then drawn by the horſes, one on each ſide of the furrow, which completely harrows it and the ſides of the ridge, if eighteen feet broad.

When you want to harrow even ground or high ridges acroſs, with the ſcrew you can bring the harrow to be horizontal, ſo as to work as a ſolid harrow without a joint.

The teeth are formed and fixed in the common manner, ſquare, not in the faſhion of coulters, and are nine or ten inches below the wood, and of ſuch ſtrength as is thought the land requires. The teeth cut, or rather tear the ground at every four inches without variation, though ſeemingly placed irregularly without any riſk of choaking, except ſometimes at the extreme angles, where the teeth are neceſſarily near each other, which may be cleaned with the greateſt eaſe, by raiſing them a little from the ground. The figures 1, 2, &c. point out where the twelve teeth on each ſide the harrow are placed.

Where a ſtrong brake-harrow is not neceſſary, by making the teeth ſhorter or lighter, you may have forty-eight teeth, which will tear the ground at every two inches, or near it, cover the ſeed well, and make a fine mould.

It is recommended, that harrows for every pnrpoſe, and of any ſize, be made on the above principle, from which no tooth can ever follow the track of another, and all are kept conſtantly acting.

Fig. 3 and 4, the plan and profile of a harrow, likewiſe invented by Mr. Sandilands, called a Wrack Harrow, from its very expeditious manner of bringing the wrack or roots of couch-graſs and other weeds together. It conſiſts of a plank of timber, ſix feet long, nine inches broad, and two inches thick, in which there are two rows of teeth fixed, twelve in front, and thirteen in rear, about four inches row from row, and about five inches from each other, which, in effect, brings the teeth to operate at two inches and a half one from another. They are in length about ſeven inches below the wood, three quarters of an inch ſquare, not ſharp, but pointed diamond ways, ſo as not to penetrate the ſoil, but only to catch what by preceding thorough harrowing is brought above ground. To the plank is joined ſhafts for a horſe, and handles for a man, of ſuch length and ſtrength as any workman may think neceſſary.

The manner of uſing the harrow is as follows: When the land is ſo well harrowed as that all the roots of the quickens or couch-graſs, &c. are brought to the ſurface, the harrow is drawn acroſs the field, the holder preſſing a little, not much, on the handles, till the plank is immediately over the firſt furrow; on which, without ſtopping the horſe, he ſuddenly lifts the harrow which the ſhafts ſupport before; by this means, all the ſtuff gathered by the harrow, drops in the furrow, ſo on he muſt go; and when he has croſſed the field, he turns to the right or left, and croſſes the ridges again, as mentioned, obſerving not to miſs any of the land, keeping cloſe by the laſt track. From this operation, the whole wrack, &c. is left in the furrows, ready to be carried off the field, or burnt, as the farmer chuſes. If the horſe is not ſteady, a boy muſt be employed to lead him.

III. *Queries*

III. *Queries of Mr. Le Blanc, reſpecting the Culture of Turnip-rooted Cabbages, with Anſwers to the ſame. By Sir* THOMAS BEEVOR, *Bart.*

A very ſhort paper of little conſequence.

IV. *On Various Subjects. By the ſame.*

THE moſt important article in this paper, is the ſet of queſtions addreſſed by the Commiſſioners of the Land Revenue to the Chairman of the Quarter Seſſions of the County of Norfolk, reſpecting oak timber, with their anſwers. Norfolk, indeed, is not a county of ſo much conſequence as many others in this reſpect; but we ſhall copy the general obſervations with which it is concluded.

"The growth and improvement of oak timber, is certainly a matter of ſo much conſequence, and of ſuch great national concern, that the want of it cannot be too greatly dreaded, or precautions for the prevention of it too ſoon adopted: however, at preſent there does not ſeem to be in this county any juſt ground to apprehend the want of it, at leaſt of ſmall timber. The only two ports of note here, for building and repairing ſhips, are Yarmouth and Lynn, in which there has been no alteration in the price of timber for many years, excepting only ſmall *occaſional* fluctuations in it. And if the price of large oak timber has in the kingdom at large increaſed (as it is ſaid to have done) from 7s. 6d. to 10s. per load, it ſhould at the ſame time be remembered, that the conſumption of oak timber between the years 1777 and 1783, ſix years only, was more than for the preceding 23 years. In the year 1783, I have been informed there were 43 ſail of the line, and 52 forty-gun ſhips building in the public and private yards; beſides ten Eaſt-India ſhips of 900 tons each."

V. *On Mowing Cabbage. By the ſame.*

The chief purpoſe of this letter is to ſay, that the writer did not find this plant to ſhoot again after being fed down.

VI. *On Accuracy in the characteriſtic Diſtinctions of Plants. By the ſame.*

BY characteriſtic diſtinctions, the writer does not mean botanical, but economical. He would have to be mentioned along with their other properties, the principal circumſtances of importance in their uſe and culture.

VII. *On the beſt Method of planting Mangel-Wurzel, and of its Uſe and Value for feeding Pigs, Cattle, &c. By Mr.* JOSEPH WIMPEY.

THE method he propoſes, is plowing the ground into ridges, three feet from the middle of one furrow to that of another, and dropping the ſeeds eight or nine inches apart, one row in each ridge. He found the leaves very acceptable to pigs and cows; and the roots, cut in ſlices, readily eaten by them in the winter. Their greateſt inconvenience is the quantity of mould ſticking to them, which is held by the fibres, ſo as to be difficult to ſeparate. On the whole, he gives a more favourable account of this plant than ſome others have done, thinking it will afford a large quantity of deſirable food, from the beginning of July to the end of December; but he fears that in ſevere winters it cannot be depended upon after Chriſtmas.

VIII. *On the Cauſe of Smut in Wheat. By the ſame.*

IN continuation of a paper on this ſubject in a former volume, the writer relates the event of ſowing 21 grains out of a ſmutty ear, firſt ſteeping part of them in water alone, part in a ſtrong brine beſides. All theſe produced perfectly healthy and thriving plants, the grains of which were perfectly free from ſmut. Thoſe which had been ſteeped in the brine put out many more ſtalks than the other. Five grains, ſmutty at one end and ſound at the other, were alſo ſown, of which only one came up. It ſhot well, but had always a ſickly look; and when it ripened, 23 out of 24 ears were found entirely ſmutty.

IX. *On the Drill Huſbandry. By the ſame.*

This letter only mentions the writer's doubts as to the preference of drilling in ſingle or in ſeveral rows.

X. *On Field Mice, and the Tranſplantation of Wheat. By the ſame.*

THE writer obſerves, that when heavy continual rains prevent the ſowing of wheat at the proper period, a reſource may be found in tranſplanting in the ſpring roots of wheat taken from the tuſſocks that ſhoot up where reſervoirs of corn collected by the field-mouſe are lodged. This little animal commits greater ravages than perſons are generally aware of. Their neſts may be found by a ſmall heap of mould thrown up at the entrance of their runs, which lead by many winding paths to the reſervoir. The writer concludes with remarking, that if a ſmall piece of ground were thickly ſown with wheat at the uſual time, it might be tranſplanted early in ſpring into prepared ground, and would probably yield as well as a ſown crop.

XI. *On the grafting Crab-Stocks, White Thorns, &c. with Apples and Pears. By the ſame.*

A PROPOSAL to engraft with fruit ſcions the ſtems of hedge plants at certain intervals, ſo as to form a kind of boundary orchard, at no expence of ground or manure.

XII. *On*

XII. *On the ſaccharine Quality of Pears, Maple Sugar, &c. By the ſame.*

FROM the ſweetneſs of pears, eſpecially after being acted upon by fire, a hint is taken of the poſſibility of extracting ſugar from them. The writer is alſo attempting to raiſe ſugar-maple plants, from ſeeds ſent from America.

XIII. *On Mangel-Wurzel, and other Crops for feeding Cattle. By* J. FRANKLEN, *Eſq.*

Some very brief and general obſervations.

XIV. *On Wool, Sheep, &c. By the Rev.* CHARLES ONLEY.

THE general purport of theſe obſervations is to ſhew the impolicy of attempting excluſively to rear ſheep, either of enormous carcaſe with coarſe long wool, or of a ſmall carcaſe with a ſmall quantity of the fineſt wool. He remarks on the different breeds in different parts of the iſland, which all degenerate when removed. He obſerves, that the Norfolk breed comes neareſt of them all to the Moufflon, or wild Tartarian ſheep. He recommends the rearing of ſheep to gentlemen, as the kind of grazing moſt likely to anſwer to them; and he thinks that in England, perfection in the carcaſe and approach to it in the wool, are moſt agreeable to our climate, and ſuitable to our culture and population.

XV. *On Planting, Grafting, and making Cyder. By* J. N. MORSE.

THIS paper, conſiſting entirely of practical directions, is incapable of abridgment. We ſhall copy that part which relates to the planting, which, alone, appears to have any novelty.

" After the apples are ground in a mill, and the juice for cyder (or if crabs, the verjuice) is preſſed from the rind, ſtalks, core and kernels; this is called the *muſt*, and ſhould be crumbled quite ſmall, and laid thin on a board floor to dry; for if it be laid thick, it will heat and deſtroy the vegetation of the kernels. To prevent its heating it ſhould often be turned with a malt-ſhovel.

" Prepare a piece of ground by well digging and clearing from weeds, keeping the ſurface ſmooth; and in February or March lay the muſt thereon, and ſhovel-turn it in, that it may be two inches deep; in about ſix weeks the young plants will appear, and muſt be kept clean from weeds; let them remain two or three years in the ſeed-beds, when they ſhould be taken up, and the tap-root cut off, as alſo ſome of the ſpreading branches. There now ſhould be another piece of ground prepared by double digging, wherein to tranſplant the ſtocks, laid out in beds four feet wide; plant them in rows acroſs the beds about one foot diſtance between the rows, and eight or ten inches diſtance in the rows; let them ſtand here three years, when they muſt again be taken up, the roots and tops dreſt, and planted in rows about eighteen inches diſtance in the rows, and three feet between the rows; but four feet is better, as it will be more room to dig the ground between them, which ſhould be done at leaſt once a year, and kept clean from weeds, &c. by hoeing. Tranſplanting them twice, and pruning their roots, makes them root better and ſtronger, and commonly riſe with a wig or fibery root.

"They are to ſtand in this nurſery until of ſufficient ſize to plant in orchards; ſome may be large enough when ten years old, others not until fourteen or fifteen; for they may be of very different ſizes, although ſown and planted at the ſame time. Here they are to be carefully trained up ſtraight, and pruned every year, by cutting off five or ſix of the largeſt knots or ſprays each year, and not many more in one year, as it would make the ſtock grow top-heavy and throw out more branches. This pruning ſhould be done in the ſpring ſeaſon, as the wounds will heal ſooneſt when the ſap is riſing; but if pruned in autumn or winter, the wounds will be long in healing, and be very black, and continue ſo for years.

"Stocks ought to be ſtrong for planting orchards that they may the ſooner grow out of the way of cattle, which very often does them great injury. The ſize I chooſe to plant is from one inch and a quarter to one inch and a half in diameter at the grafting place; that is, about five feet ſix inches from the ground.

"The method I purſue in planting orchards is, firſt lay out the field by ſetting up ſtakes equidiſtant; twenty or twenty-two yards from each other, I look upon as the beſt diſtance. After they are properly arranged, dig a hole conſiderably larger than will take the roots of the ſtock, that the earth may be ſoft and mellow for them to ſtrike therein more freely; have your ſtock ready with the roots and head pruned, particularly thoſe that were bruiſed in raiſing; place it upright in the hole. If ſome better mould, ſuch as ſtreet ſhovellings, or a compoſt made with rotten dung, good mould and lime, (lime kills the ants, which are very deſtructive to ſtocks and trees,) were mixed with the ſoil to fill the hole, it will expedite the growth of the ſtock. Care ſhould be taken to fill up every vacancy between the roots, ſhaking the ſtock well whilſt filling; when filled, tread the earth down to the roots pretty hard, then have a ſtake four or five feet long driven ſideways in the ground leaning againſt the ſtock, pointing to the weſt wind, and firmly tie the ſtock to the ſtake with an ozier twig, placing a hayband between the ſtock and the ſtake, to prevent galling; this will prevent the wind ſhaking the ſtock, which very often injures it, and prevents its taking root. We ſhould then have ſix or eight black-thorns, pointed and ſtuck in the ground round the ſtock, reaching up to the head: theſe ſhould be tied in two places with twigs, to prevent cattle or ſheep from brouſing on, or rubbing, or peeling the ſtocks, which they are very apt to do, particularly young ſheep. I have had ſtocks peeled quite round by ſheep. The greaſe of the wool, when ſheep rub againſt them, injures and retards their growth. Where wood is plenty, if three poſts be erected triangularly round the ſtock, and laths nailed to the poſts, it is the beſt fence. The ſtocks muſt now ſtand three years to take full root; at the expiration thoſe that have made free ſhoots ſhould be grafted with what ſort of apples the planter may pleaſe."

XVI. *On a particular Kind of Apple, &c. By Mr.* J. Holt.

A kind of pippin in Lancaſhire, remarkable for ſweetneſs.

XVII. *On tranſplanting Wheat, &c. By the ſame.*

XVIII. *On the Loſs of Weight in Grain, &c. By the ſame.*

Some experiments on the evaporation undergone by grain and potatoes on keeping, too ſlight for any deciſive concluſions.

XIX. *Obſervations on the Subjects propoſed by the Bath Society, in their circular Letter of July* 30, 1791, *for Enquiry of the ſeveral Perſons to whom the ſaid Letter was addreſſed. By* Thomas Davis, *Eſq.*

THE firſt relates to the miſchief done to trees by ſquirrels, in gnawing their bark. The writer found them to attack only Scotch firs, and of theſe the moſt luxuriant and with the thinneſt bark. The time was in March and April. This leads him to ſome obſervations on planting, particularly as to managing plantations ſo as to be a ſhelter to themſelves, for which purpoſe it is neceſſary to make them big enough, and to thin them early and often, ſo as gradually to enure them to the cold.

The obſervations on oak timber, as to its ſuppoſed ſcarcity and neglect, begin with the principle, that as timber is an article of commerce, the ſcarcity of it muſt ariſe from an increaſed demand or leſſened production. In point of fact, the writer is convinced that the imagined ſcarcity is a chimæra, in proof of which he affirms, that the price of navy timber has rather fallen than riſen. This is partly owing to the cheaper carriage from the inland counties by means of canals, and partly to the diminiſhed uſes of oak for other purpoſes, particularly in building. If oak were only wanted for ſhip-timber, there might be danger that it would be thought hardly worth growing; but there are many thouſand acres in the kingdom where it is the *weed of the country*, and grows without planting; and there are other uſes of it which will make it an object of attention. Theſe are the great and increaſing demand of bark for tanning; the vaſt demand of the wood for beer caſks, and that for laths and ſpokes for wheels. As to the ſociety's queſtion whether larch could be made a ſubſtitute to oak, the writer ſtates his reaſons why it cannot; ſince larch is a *ſtraight-grained* tree, and can never be applied to the *crooked* uſes of a ſhip. He thinks larch has been rated higher than it deſerves as timber, and Scotch fir lower.

XX. *On Smut in Wheat; new Method of ſowing by Hand, &c. By Mr.* James Wyborn.

THE writer combats the idea that the ſmut is occaſioned by a cold wet ſeaſon when the wheat is in bloom, by obſerving that ſmutty ears never bloom, and that the ſmut is to be diſcovered as ſoon as the wheat is in ear. He is certain that blight is generally not the cauſe of ſmut. He thinks the greateſt improvement the old huſbandry has met with in this century, is the new method of ſowing by hand, which he thus deſcribes.

The old method was to ſow in warps, viz. 20 furrows at the time, proceeding down the right hand ſide of the warp, and returning on the left ſide, caſting the ſeed with the right hand acroſs the warp, the whole was finiſhed, and probably, as either going or returning the ſeedſman was obliged to caſt againſt the wind, the work was badly done. By the new method, the ſeedſman always caſts before the wind, takes a leſs quantity in his hand, and advances ſeven furrows each time, which is about three times over a warp, exactly as tiles are placed; if in the beginning he proceeds to ſow with his right hand, at the end he advances ſeven furrows and returns ſowing with his left hand, proceeding alternately with his right and left hands, till the field is finiſhed; the only care required is to deliver the corn thin on the mark, by which method it is in all weathers accurately ſown, and not liable to be hand-platted.

In drilling, he finds that ſeven inches is the moſt profitable diſtance of the rows for the farmer, nine or ten inches leaving a poor crop, except on very rich land.

XXI. *On the Smut in Wheat continued. By the ſame.*

THE notion here ſtarted is, that ſmut ball is a ſubſtance of a paraſitic or hybrid nature, produced on the wheat plant, as he affirms that cockle alſo is, ears being found which contain part cockle and part wheat. However this be, he thinks it a fact that ſmut is generally produced by ſmut, and therefore looks for a cure in ſome cauſtic ſubſtance applied to the ſeed, of which he reckons ſolution of arſenic both ſafe and efficacious. In a poſtſcript to the letter, he mentions that his gardener, on finding a female cucumber flower expanded before any male was preſent, makes a practice of ſprinkling it with dry duſt from the border, in conſequence of which it produces as fine fruit as with the aſſiſtance of the male farina.

XXII. *Thoughts on the ſame Subject. By* W. R.

THE writer thinks that avoiding to ſow infected ſeed, and liming it plentifully, are the beſt preventatives of ſmut. He conceives the diſeaſe to begin while the grain lies on the ſurface of the ground, or ſlightly covered. He recommends ſowing before the ſevere froſts commence.

XXIII. *Further Remarks on the Cauſe of the Smut in Wheat, and on planting Potatoes.*

By Mr. JOSEPH WIMPEY.

THIS writer, ſince his former letter on the ſame ſubject, has made many experiments for the purpoſe of inveſtigating the cauſe of the ſmut, which, however, have afforded no new diſcovery, but have corroborated his former opinions. He found that ſteeping in various liquors the ſound corn taken from ſmutty ears produced no effect, for the grain all came up ſound, however differently prepared, or with no preparation at all. He anſwers the objection made againſt his opinion of the cauſe of ſmut reſiding in the atmoſphere—that adjoining fields ſown with different corn, but blooming at the ſame time, have been found ſome free from ſmut and others full of it—by obſerving that atmoſpherical vitiations frequently are confined to ſtreams or currents, and that the eaſt and ſouth ſides of a field are often very ſmutty, when the north and weſt are very little ſo. He urges thoſe who attribute ſmut to the ſeed, with the fact, that ſound and ſmutty grains are often found from the ſame root, and even in the ſame ear; and he relates two caſes, one of very ſmutty wheat produced from choice clean ſeed, the other of ſound wheat produced from very ſmutty ſeed.

With regard to planting potatoes, he ſtates an experiment to prove that planting whole ones, and cuttings, makes very little difference in the product, but that as cut ones will go four times as far as whole, they deſerve the preference. He mentions the fact, that poor people not unfrequently plant the parings of potatoes after having eat the reſt, and get as good crops as in any other way.

XXIV. *On the beſt Method of providing for the Poor.* By W. M.

AFTER ſome preliminary remarks by the writer, on the importance of the ſubject, and the different ſchemes that have been propoſed, a ſmall pamphlet of Mr. Pew's, entitled, *Twenty Minutes Obſervations on a better Mode of providing for the Poor*, is reprinted. In this, a plan is ſuggeſted of providing for the neceſſitous poor, by means of a monthly payment out of their earnings, on the footing of the voluntary clubs among themſelves eſtabliſhed in ſo many places. The firſt writer then ſubjoins ſome remarks on this plan, intended to obviate any difficulties in its execution; and he afterwards falls into ſome obſervations on the utility of ſetting up breweries of good ſmall beer in country places, for beverage for the lower claſſes of people. The article concludes with a letter from Dean Tucker on Mr. Pew's plan, in which he gives his opinion that the clubs for ſupport of the poor ſhould be voluntary and not compulſory aſſociations.

XXV. *A Plan for the better Maintenance and Regulation of the Parochial Poor.*
By THOMAS HALL, *Eſq.*

THE idea on which this plan is founded, is the giving, at the diſcretion of the juſtices of the peace, a bounty on work in certain caſes, namely, a ſum proportioned to the earnings of each poor family.

XXVI. *On the Damage of Fir Plantations.* *By* J. BARNARD, *Eſq.*

THIS letter confirms the fact of the miſchiefs occaſioned by ſquirrels to the Scotch fir, by ſtripping the bark in the months of April and May, probably when they have exhauſted their ſtore of winter proviſions.

XXVII. *On the Subject of the foregoing Article, Planting, &c. By Mr.* B. PRYCE.

He is of opinion that the growth of timber is on the decline, and recommends encouragements to tenants for the rearing of young trees.

XXVIII. *The ſame Subject continued.* By JOHN WARD, *Eſq.*

Chiefly relative to Lord Ayleſbury's plantations, but containing nothing remarkable.

XXIX. *On Shetland or Zetland Sheep and Wool.* By *Mr.* J. TOMPSON.

FROM this account it appears that the Zetlanders are a very oppreſſed people, holding their lands only from year to year, and on condition of perſonal ſervices, ſo that they have few motives to induſtry or improvement. Their chief ſubſiſtence is from fiſhing and knitting of ſtockings. The Shetland ſheep are ſmall, bearing about two pounds of wool, of which about one fourth is very fine. Their number is about 90,000, but capable of great increaſe under proper management. Some of the cauſes preventing increaſe are here ſtated. The writer propoſes that a company of clothiers ſhould take a ten or twelve years leaſe of as many *ſcattalds* (paſture grounds) as poſſible, with all the ſheep upon them. Shepherds ſkilful and to be depended upon, ſhould be got from Scotland. Wool-ſorters ſhould be appointed, and the Zetlanders ſet to ſpin yarn to be ſent to the Engliſh manufactures. With reſpect to the fineneſs of the Shetland wool, he ſuppoſes it to be owing to various cauſes; as the peculiar breed of ſheep, the nature of the paſture ſtrongly impregnated with ſaline particles, the cuſtom of plucking the wool, and the northern ſituation.

XXX. *On miſcellaneous Topics of Huſbandry.* By J. FRANKLEN, *Eſq.*

THE writer firſt mentions his ſucceſs in feeding horned cattle, horſes, and pigs, with raw potatoes. They eat them greedily, and he thinks they were worth to him for this purpoſe about 20s. per ton. Sheep could ſcarcely be got to touch them. The other topics of the letter are very ſlightly touched. He complains heavily of the effect of tithes in diſcouraging improvements.

XXXI. *Extract of a Letter from a Gentleman in Scotland concerning the Ruta-Baga.*

THE ruta-baga, or Swediſh turnip, is ſmaller and longer than the common, of ſuperior flavour, and much firmer and heavier. It is hardy and keeps well, and is readily eaten by cattle. The writer firſt ſowed them in a garden and tranſplanted them; but he afterwards ſowed them in the field in drills, the firſt week in June, laying out the plants like common turnips, which anſwered better. They prove very uſeful food in April, before the graſs is ready.

XXXII. *On Butter-making, and the Author's Pamphlet on Dairying.* By *Mr.* J. TWAMLEY.

NOTICES a French publication on milk, the opinions in which are ſimilar to his own, particularly reſpecting the bad effects of heating the milk, in order to produce a greater quantity of cream.

XXXIII. *Remarks on planting Incloſures, &c.* *By* E. C. *Eſq.*

THE propoſal of this writer is, that the hedges in incloſures, inſtead of being made of unproductive plants, ſhould be converted into a kind of fruit garden, in the following manner:

Plant at the diſtance of every twelve, ſixteen, or twenty feet, a Spaniſh cheſnut, midway plant a crab, midway between the cheſnut and crab plant a common plum-ſtock, midway between the ſeveral cheſnuts, plum, and crab ſtocks, plant a white-thorn; when theſe ſeveral plantations have been made three or four years, and are in a thriving ſtate, about the end of February or March, cut them off with a ſharp knife, about an inch or two from the ground; they will then throw out many ſhoots; keep them well weeded, and let them continue growing until the cheſnut ſhoots are large enough for ſtakes and binders, which will be in about ſix, ſeven, or eight years, according as the ſoil ſuits the plants; when the plants are formed into a hedge, for which there will be a plentiful ſupply of ſteepers, ſtakes, and all the requiſite materials; at the diſtance of every hundred, hundred and fifty, or two hundred feet, or at whatever diſtance fancy leads you, leave a ſtraight handſome ſhoot of the cheſnut, to grow into a tree; if you prefer timber, let it remain, and it will grow into a good timber tree: if fruit, let it be grafted with grafts from the beſt cheſnuts you can obtain; it would be deſirable if you had an opportunity to procure the grafts from Spain; in like manner leave a ſtraight handſome ſhoot of the crab-ſtock, and graft it with an apple; in like manner leave a plum-ſtock, and graft it with a damſon, or any good bearing plum; likewiſe leave a handſome ſhoot of the white-thorn, and graft it with a medlar; thus will you have a very productive fruit-garden, that will always continue, as you may perpetually renovate by leaving freſh ſtocks every time the hedge is new made, without any waſte of ground, and a permanent hedge equalled by few, and by none excelled.

He makes ſome obſervations on the utility of theſe products, and anſwers the objection of their tempting pilferers to break the hedges, by remarking, that it is their ſcarcity which affords the temptation, and if by ſuch means they were rendered common, they would ſuffer little depredation.

XXXIV. *On the Culture of Rape as Food for Cattle.* *By Mr.* RAWSON.

THE writer made an experiment of cultivating rape as cabbage, planting it in furrows in a turnip field. It was exceedingly luxuriant, averaging above 20 pounds a-head, and was eaten by ſheep with great eagerneſs. He calculates that one acre of rape is equal to three of turnips, and gives a ſtatement of expence and profit which is highly favourable, more ſo, as the editor obſerves, than can be relied on for common practice.

XXXV. *On the Maple Sugar of America.* *By Mr.* CLIFFORD.

THE ſugar-maple is a native tree of the interior woods in North America, from latitude 35 to 45, at the diſtance of 100 to 150 miles directly from the ſea. Though ſugar for private uſe has for a number of years been made from it, yet it has not been made for ſale till within three or four years paſt. From the beſt enquiries the writer could make, it appears, that trees from 18 to 30 inches diameter, on tapping, will yield about 40 gallons of ſap, which afford about five pounds of ſugar on inſpiſſation. The ſap generally begins to run in February, and ceaſes by the end of March or beginning of April. It has been ſaid, that large tracts in America contain upon the average 50 ſugar-maple trees; but taking the face of the country for ten miles ſquare, Mr. Clifford is of opinion, that it does not yield above five of a ſize fit for tapping. He thinks that it is not of value ſufficient to be worth cultivation, but that where it grows ſpontaneouſly and upon lands not yet capable of full cultivation, it is and will be of conſiderable benefit to the inhabitants. The ſugar-maple in Pennſylvania grows to the height of 80 or 90 feet. Its leaves are exactly ſimilar to thoſe of the common maple, but its bark is more like that of the Engliſh oak. It abounds moſt in ſtony ground in hilly countries, and among ſprings or ſmall brooks.

Mr. Clifford concludes his letter with mentioning an article of manure of great uſe in Pennſylvania, which is plaiſter of Paris imported from France. It is uſed ground and unburnt, and one buſhel is reckoned to go as far as ten of lime.

XXXVI. *Obſervations on a Tour into Suffolk and Surry.* *By* R. P. ANDERDON, *Eſq.*

Theſe conſiſt of curſory accounts of the farming of Mr. Young, Mr. Mure, Mr. Duckitt, &c.

XXXVII. *On the Expediency of ſowing Wheat occaſionally in the Spring.* *By Mr.* WIMPEY.

WHAT is generally called *ſpring* wheat, is repreſented by writers as a peculiar ſpecies; but Mr. Wimpey aſſerts, that every ſpecies, if ſown in February, will produce good plump corn, and be ripe and fit to reap in due ſeaſon. He does not mean by this to ſay that autumn is not generally a more proper time than ſpring to ſow wheat; but only that when from the unſeaſonableneſs of the weather and foulneſs of the ground, it cannot prudently be ſown in October, it will be better to give the ground a winter fallow, and ſow in February than in November.

XXXVIII. *On the Culture of Potatoes.* *By* JOHN BILLINGSLEY, *Eſq.*

THIS paper begins with ſome obſervations on the ſuperior profit of the culture of potatoes to that of turnips. The writer then mentions that he began eight years ago a courſe of experiments to aſcertain the value of potatoes as food for cattle, the reſult of which he is now to lay before the ſociety. With reſpect to the curled diſeaſe of this root, he cannot ſpeak deciſively, no method that he has tried having been effectual in preventing it. But he recommends changing the ſeed every two years, and going as far as poſſible from home for a ſupply. He has not found that whole potatoes anſwer beſt for ſeed. He prefers the promiſcuous mode of planting to the drill.

The firſt ſet of experiments are 16 in number, which are circumſtantially related, with ſtatements of expences and produce, and obſervations on each. From the recapitulation of theſe it appears, that the number of acres cultivated with potatoes in the whole was 301; that the average expences per acre amounted to 9l. 9s. 3d. the average produce per acre, about 70 ſacks of 240 lb. each; and the average prime coſt of theſe, about 2s. 9d. per ſack. The ſecond ſet of experiments relates to feeding hogs with potatoes, and are nine in number, ſome on a very large ſcale. The potatoes were boiled, and it was obſerved that the hogs eat them better when ſlightly boiled, than when reduced to a pulp. From the recapitulation it appears, that eſtimating the potatoes at 2s. 9d. per ſack as the prime coſt, a conſiderable loſs was incurred during the nine years' experiments, and that for the purpoſe of feeding ſwine, they are not worth above 2s. 6d. per ſack. Mr. Billingſley is proceeding in a courſe of experiments on the value of potatoes as a food for horſes, cows, fatting oxen and ſheep.

Tranſactions of the Royal Iriſh Academy, 1787. *Dublin.* 4to.

IN the preface the writer laments that Ireland has remained in a great meaſure a ſtranger to the advantages experienced in Europe by the cultivation of ſcience and polite literature. Of this our author ſlightly traces the cauſes. Theſe cauſes having now in a great meaſure ceaſed, knowledge begins to advance; to promote which, the Royal Iriſh Academy for *Sciences, Polite Literature, and Antiquities*, was inſtituted. One ſcience is ſo connected with the reſt, that the Academy have determined to take an extenſive field.

In 1686, Mr. Molyneux formed a Society in Dublin, ſimilar to the Royal Society of London; but in 1688 they were diſperſed, and their plan was reſumed, but without ſucceſs, in the beginning of this century. In 1740, the Phyſico-Hiſtorical Society was inſtituted; there are two volumes of their Memoirs extant, and under their patronage, Smith publiſhed his Hiſtory of Waterford. In 1772, the Dublin Society appointed a committee for the purpoſe of enquiring into the antiquities of Ireland. The meeting of this committee ceaſed in about two years, but a few members have given to the public ſeveral Eſſays ſince, comprized in four volumes, entitled, *Collectanea de Rebus Hibernicis.* About the year 1782, the Society from which this Academy aroſe, was eſtabliſhed, and conſiſted of many members, moſt of them belonging to the Univerſity, who at weekly meetings read eſſays in turn. Theſe gentlemen afterwards formed a more extenſive plan, and became founders of the Royal Iriſh Academy. This volume is the firſt fruit of their labours, and contains, in the department of ſcience,

I. *Account of the Obſervatory belonging to Trinity College, Dublin. By the Rev.* H. USSHER, *D. D.*

DR. USSHER obſerves, that the improved ſtate of aſtronomy has laid open new ſources of error and additional difficulties, which the leſs perfect inſtruments of our predeceſſors could not have taught us to ſuſpect. That the theory of refractions, even as coming from the hands of Bradley, was ſtill liable to ſuſpicion, as his experiments were made in a confined room, and by the help of inſtruments cloſely attached to a maſs of ſtone, which leaves the ſubject ſtill liable to well founded objections.

Dr. Maſkelyne, aware of this defect, opened his obſervatory more to the air, but the quadrants, however, remain ſtill attached to a great maſs of ſtone. Since the introduction of metallic inſtruments and teleſcopic ſights, the groſſer difficulties have been gradually removed; but others are now become of ſerious conſequences. Among which may be ranked the minute variations of refraction.

Dr. Uſher ſuſpects that the true conſtitution of our atmoſphere is little known; we are certain, however, that it is ſubject to decompoſition and change, and our obſervations prove that refractions are thereby affected.

Obſervations made in the open air, promiſe the greater degree of conſiſtency, but as that method cannot be purſued with ſafety in theſe northern latitudes, it requires that an obſervatory ſhould be conſtructed in a peculiar manner. Dr. Uſher ſays he had long conſidered this ſubject, when he was fortunately called on to reduce part of his ſyſtem to practice. Dr. T. Andrews the late provoſt, having bequeathed to the college of Dublin, a conſiderable ſum of money to build an obſervatory, the college elected Dr. Uſher profeſſor, who deviſed a plan which the college was pleaſed to adopt, and committed to him the ſuperintendance.

In this building (of which a plan and elevation are given in the Tranſactions) perfect ſtability and convenient diſpoſition of the inſtrument form the great object.

The building of an obſervatory, the Doctor ſays, muſt neceſſarily be low, as the preſent refinement of aſtronomical inſtruments require the greateſt ſtability. The ſituation ſhould however be elevated, and command a clear horizon. It muſt have a foundation of the moſt ſolid kind, for which reaſon a rock or hard gravel ſhould be made choice of, if theſe are not to be found it will be neceſſary to give all the ſtability in our power by deep arches or piles driven by an engine. The execution of modern inſtruments is ſo conſummate, that they immediately betray the imperfections of a building.

The ſoil ſhould be naturally dry. The advantages of a dry ſoil Dr. Uſher has frequently ſeen at the obſervatory, Greenwich, where the air has been ſerene, while the country round has been covered with a thick fog.

The obſervatory of Trinity College, Dublin, is built on a high ground, where the mercury in the barometer ſtands $\overset{\text{In.}}{0.254}$ lower than at high water mark in the Liffey in ſpring tides. It is founded on a ſolid rock of limeſtone, ſo hard as to be blaſted by gunpowder. The horizon is remarkably extenſive, and no interruption but from the Wicklow mountains.

On the ground plan is a baſe of a ſolid pillar 16 feet ſquare, of ſubſtantial maſonry, and raiſed to ſuch a height, that the equatorial inſtrument it ſupports may overlook every part of the building. A ſubſtantial wall ſupports the dome, and the floor of the room, which neither touches the pillar or the piers which ariſe from it. In the floor are places to let the pillars paſs through untouched, ſo that no motion of the floor or wall can be communicated to the inſtrument. The dome is of wood, each rib conſiſting of three equal and parallel pieces, ſo diſpoſed as to counteract each other's inclination to caſt or warp. The frame is covered with canvaſs ſoaked with drying oil, tar, and white paint, and coated afterwards with white paint laid on with a trowel.

a trowel. The inſide is covered with another thinner ſheeting, and between the two, wood-moſs, if neceſſary, will be introduced, to prevent the tranſmiſſion of heat. The room for obſervations is placed in the weſt of the buildings, to ſecure the obſervatory from the effect of the ſmoke of the city.

A broad croſs of the moſt ſolid maſonry is laid down in a block of Portland ſtone, nine feet two inches long, three feet broad and four inches thick, which ſupports the pillars of the tranſit inſtrument. Theſe pillars are ſeven feet ſix inches high, their baſes three feet from north to ſouth, and two feet ſix inches from eaſt to weſt. Theſe pillars are each one ſolid piece of Portland ſtone, and although each be a heterogeneous maſs, yet their relative parts at given altitudes are perfectly ſimilar. The temperature of theſe pillars is ſhewn by thermometers, their tubes bent at right angles, and their bulbs inſerted in the ſtone.

Near the weſtern end of the croſs ariſe four pillars, for the ſupport of the frame of the vertical meridian circle, and a block of Portland ſtone is ſo placed as not to touch the pillars or the floor, to ſupport the vertical axis.

The floor is ſo framed as to let all theſe pillars riſe detached from it, with leather to prevent the admiſſion of duſt.

Dr. Uſher mentions ſome advantage which will ariſe from placing the tranſit inſtrument, and thoſe adopted for meaſuring altitudes, in the ſame room.

To admit as free a paſſage to the external air as is proper, the meridian apertures are ſix feet wide, with ſcreens of the thinneſt canvaſs, there are alſo ſemicircular air-holes in the walls, grated and covered with the ſame kind of canvaſs.

The ſouth wing is deſigned for occaſional obſervations, ſuch as eclipſes, occultations, &c. and the center of the ſouthern dome is ſo far removed towards the ſouth, that a line drawn from thence to the extremity of the meridian room, will clear the greateſt amplitude of any of the planets in this latitude.

There are baſes of pillars which riſe to the dome, formed to ſupport a polar axis, carrying an achromatic teleſcope, to which it is propoſed to add an helioſtatic movement, that will carry it round with an equable motion in a ſidereal day. From which apparatus the doctor thinks many advantages may ariſe. A lower room is deſigned to permit occaſional obſervers to practice, to prevent the inconvenience of two obſervers in a room.

Account of Parhelia, ſeen at Cookſtown September 24, 1783. *By the Reverend* JAMES A. HAMILTON, *D.D. M.R.I.A.*

"WEDNESDAY, September 24th, 1783, as I was preparing to obſerve the ſun paſſing the meridian, before the firſt limb touched the center wire, it was obſcured by a dark well-defined cloud, about 10° in diameter. Upon going to the door of the tranſit room, to ſee if it was likely ſoon to paſs off the diſk of the ſun, I obſerved the following phænomena:

"From the weſtern edge of the cloud iſſued a luminous arc parallel to the horizon, perfectly well defined, extending exactly to the northern meridian; it was about 30′ broad, white, and ended in a blunted termination. On it were two parhelia; the neareſt to the ſun diſplaying the priſmatic colours; the remote one white, and both ill defined. In a ſhort time the cloud paſſed off, and ſhewed the luminous almicantar, reaching perfect to the true ſun. While things were thus ſituated, I meaſured with an accurate ſextant the diſtances of the parhelia; I found the coloured one 26°, the remoter one 90°, from the true ſun. Juſt as I had done this, a new and priſmatic circle ſurrounded the ſun, immediately within the priſmatic parhelion. And now another coloured parhelion appeared on the eaſtern board. The ſextant with its face up and down, exactly meaſured this and the former at the original diſtance of 26°; the luminous almicantar ſtill remaining perfect. In about ten or twelve minutes, whitiſh hazy clouds came on, and obſcured all theſe uncommon appearances. I did not obſerve that the atmoſpherical phænomena before or after were at all uncommon. The wind a light breeze at S. S. W. Barom. 29,6 riſing. Therm. 55°."

Obſervations of the Lunar Eclipſe, March 18, 1783. *Communicated by the Reverend* H. Ussher, *D. D.*

"I WAS accompanied and aſſiſted in the following obſervations by the Reverend W. Hamilton, Member of this Academy, and by Mr. Arthur M'Guire.

"The latter gentleman obſerved, with an Hadley's ſextant, equal verſed ſines of the uneclipſed part, being anxious to ſee how nearly the middle of the eclipſe might be deduced from that kind of obſervation, which at ſea might be of uſe, when the weather happens to be too hazy to ſhew the ſpots diſtinctly.

"Mr. Hamilton made his obſervations with a teleſcope of two feet focus double object glaſs. I obſerved the beginning and end of the eclipſe, and the beginning and end of total darkneſs, with a night teleſcope, the aperture being diminiſhed about one third; and the other phænomena with a teleſcope of ſeventeen inches focus triple object glaſs. The obſervations are reduced to mean time, on the meridian of the college of Dublin."

	H. U. mean time.	W. H. mean time.
Beginning of eclipſe,	7*h*. 14′.. 9″	
Copernicus biſected,	7.. 34..58	7*h*. 34′..43″
Tycho biſected,	7.. 43..13	
Beginning of total darkneſs,	8.. 14.. 8	8.. 13..58
End of total darkneſs,	9.. 57..28	9.. 57..33
Tycho biſected,	10.. 19..45	10.. 20..13
Copernicus biſected,	10.. 21..13	
End of eclipſe,	10.. 56..28	10.. 57..13

"The middle of the eclipſe, deduced from a mean of ſeveral obſerved equal verſed ſines, differed but eleven ſeconds from that deduced from the beginning and end of total darkneſs.

"The aſtronomer royal was ſo obliging as to ſend me the correſpondent obſervations at Greenwich; and as the longitude of Dublin is not yet accurately determined, the difference of longitude deduced from the mean of theſe may be of ſome uſe for the preſent; theſe make it 0*h*.24′..57″,9 W. of Greenwich. In July, 1783, Mr. Arnold came here from England, and had with him one of his large pocket time-keepers, the rate and error of which had been ſettled before he left Greenwich. I determined the difference of times by equal altitudes the day of his arrival and the day before his departure; and by compariſon on his return to Greenwich, made at my requeſt, and communicated to me by Dr. Maſkelyne, the difference of the longitude by the watch was 0*h*.24′..58″,2, differing only ſix tenths of a ſecond from what I had made it by obſervation on his arrival.

" The following obſervations of the ſame eclipſe have been communicated to me:

At the Hague, middle of the eclipſe deduced from the beginnings and endings, &c.	9*h*.49′.. 7″ mean time.
At Paris, Cabinet du Roi, 14″ W. of the Royal Obſervatory,	9.. 31..58 app. time.
At Thouloufe,	9.. 29..14 app. time.

Obſervations of the lunar eclipſe, September 10, 1783, by the Rev. J. A. Hamilton, made at Cookſtown, in longitude 0*h*. 26′..48″,9 W. of Greenwich.

Beginning,	20*h*. 35′.. 1″,5 ſider. time.
Copernicus biſected,	20.. 51..16 ,5
Tycho biſected,	21.. 5..44 ;5
Total darkneſs	21.. 34.. 6 ;5

" Juſt before the penumbra was expected, there was a tolerably bright halo around the moon, at 24½ degrees from her; and in this on the weſtern ſide, in the moon's almacantar, was formed an imperfect paraſelene, the tail extending weſtward, and ill defined. The wind had been at N. W. all the evening, with light breezes, but ſuddenly died away when the paraſelene appeared; preſently the moon was covered with clouds, and the wind came to S. W. Barom. 29, 61, therm. 59¼."

A Synthetical Demonſtration of the Rule for the Quadrature of Simple Curves, in the Analyſis per Equationes terminorum numero infinitas. By the Rev. M. YOUNG, *D. D.*

DR. Wallis, about the year 1651, having met with the mathematical writings of Torricelli, in which, amongſt other things, he explains Cavalerius's attempt to render the ancient method of exhauſtions more conciſe by his geometry of indiviſibles, conceived that an arithmetic of infinites might be applied to the contemplation of curve lines with ſucceſs; and that perhaps the quadrature of the circle, were it at all poſſible, might be finally attained in this manner.

At length, by an induction of particulars, came to this general theorem, which is the 64th of his Arithmetica Infinitorum, " In any infinite ſeries of quantities beginning from 0, and continually increaſing according to any power whatſoever, whether ſimple or compounded of ſuch as are ſimple, the ratio of all the terms of ſuch a ſeries is to as many times the greateſt, as unity to the index of that power increaſed by unity." And this is the ſame in ſubſtance with Sir I. Newton's firſt rule for the quadrature of ſimple curves, in his Anal. per Equat. t. n. infin. which was inveſtigated, in the manner juſt now mentioned, by an induction of particulars by Wallis, but which Newton demonſtrated univerſally by an indefinite index, as was his manner, comprehending, in one general propoſition, all thoſe particular caſes which others had demonſtrated with limitations. In the analytical demonſtration however which he has given of this theorem, certain quantities are omitted as being indefinitely little; and therefore it is not delivered with that ακριβεια, which is re-

quired

quired in ſubjects of this nature. Fermat has given us a ſynthetic demonſtration of this theorem, which Doctor Horſely has inſerted in his notes on this tract of Newton, but it is ſo tedious and prolix, that even the analytical is preferable to it. I ſhall here give a ſynthetical demonſtration alſo of the ſame general propoſitions on the principles of *prime and ultimate ratios*, a method of reaſoning which Newton ſeems to have had ſome idea of even at the time of his writing this Analyſis, in the year 1669, though probably he did not bring it to perfection until eighteen years after, when he firſt publiſhed the Principia.

Rule I. Quad. of Simple Curves. (Plate XI. Fig. 4.)

Let the baſe AB of any curve AD have BD for its perpendicular ordinate; and let AB=X, BD=Y; alſo let a be a given quantity, and m, n, whole numbers. Then if $Y=aX^{\frac{m}{n}}$, it ſhall be, area $ABD=\frac{n}{m+n}X^{\frac{m+n}{n}}$.

Let DC, AC, drawn through D and A parallel to AB and DB, meet in C; draw the ordinate d b indefinitely near to DB, meeting CD in s; and through d draw r p parallel to AB.

Then by Cas. 5 Lem. 2. B. 2 Principia $y=\frac{am}{n}X^{\frac{m-n}{n}}x$. Now the rectangle sDBb is the rectangle under the ordinate and moment of the abſciſſe, that is, Yx; and the rectangle CDpr is the rectangle under the abſciſſe and moment of the ordinate, that is, Xy; therefore bD: Cp:: Yx: Xy; that is, ſubſtituting its value for y,

$$\text{as } aX^{\frac{m}{n}} : \frac{am}{n}X^{\frac{m}{n}}, \text{ that is as } 1 \text{ to } \frac{m}{n}.$$

By a like proceſs it may be ſhewn, that if AB be divided into an indefinite number of parts, and upon each there be conſtructed a rectangle o b in the ſame manner as on bB, and through g there be drawn t q parallel to the baſe; the rectangle o b will be to the correſponding rectangle r q ultimately in the given ratio of 1 to $\frac{m}{n}$. Therefore the ſum of all the indefinitely little rectangles sB will be to the ſum of the correſponding rectangles Cp, in the ſame ratio; therefore the curve ADB is to the curve ACD as 1 to $\frac{m}{n}$, Cor. Lem. 4. B. 1. Prin. and the curve ADB to the rectangle ACDB, as 1 to $\frac{m+n}{n}$; but the rectangle $ACDB = YX = aX\frac{m+n}{n}$; therefore the curve ADB is to $aX^{\frac{m+n}{n}}$ as 1 to $\frac{m+n}{n}$, and therefore equal to $\frac{n}{m+n}\times aX^{\frac{m+n}{n}}$. Q. E. D.

If the ordinate BD be oblique to the baſe, the area, found as above, muſt be diminiſhed in the ratio of radius to the ſine of the angle made by the ordinate and baſe.

This demonſtration being admitted, the whole doctrine of quadratures becomes a branch of *prime and ultimate ratios*, and conſequently of pure geometry.

We are to obſerve, that the reaſon why the curves treated of above are perfectly quadrable is, becauſe the rectangles inſcribed in the curve are to the reſpective rectangles inſcribed in the exterior ſpace, ultimately, in a given ratio, whence the curve will be to that ſpace (Cor. Lem. 4. Prin.) and conſequently to the circumſcribed rectangle, in a given ratio. But this is not the caſe in the circle, which therefore is not quadrable by this method, at leaſt in its preſent ſtate. But though the ratio of the rectangles inſcribed in a quadrant to their correſponding rectangles in the exterior ſpace of a circumſcribed ſquare perpetually varies from the beginning of the quadrant to the end, yet this variation is regular, beginning from the finite ratio of 2 to 1, and conſtantly approaching the infinite ratio of 1 to nothing. The law of which approach may be thus determined:

If a ſquare APCO be circumſcribed about a quadrant ACO, and the radius AO be divided into any number of equal parts whatſoever, and on theſe parts rectangles as moBD be erected, and inſcribed in the quadrant, and through the extremities of the ordinates nm, BD, right lines tp. rB be drawn parallel to the radius AO, and thus as many correſponding rectangles, as rBtp, be inſcribed in the exterior ſpace: then the breadth of theſe rectangles being diminiſhed indefinitely, each rectangle in the quadrant will be to its correſponding rectangle in the exterior ſpace as DR to DO, that is, as the ſum of the radius AO and the ſegment DO between the centre and ordinate to that ſegment.

Let the abſciſſe $AD = X$; the ordinate $BD = Y$; the diameter $AR = a$.

$Y^2 = \overline{aX - X^2}$, from the nature of the circle.

Therefore (Lem. 2. B. 2. Prin.) $y = \dfrac{ax - 2Xx}{2\,\overline{aX - X^2}^{\frac{1}{2}}}$; but moBD : Brpt : Yx to Xy which by ſubſtitution and reduction is as $a - X : \frac{1}{2}\,a - X$ or as DR to DO.

In A, the extremity of the diameter, DR is to DO as 2 to 1; as D approaches O, this ratio continually encreaſes, and in O this ratio becomes 1 to nothing.

Hence if the radius AO be divided into any number of equal parts, and there be conſtituted a ſeries of fractions, whoſe numerators are the natural numbers increaſing from unity to that number of parts, and whoſe denominators are the continuation of that ſeries; then the rectangles inſcribed in the circle will be to the reſpective rectangles in the exterior ſpace, ultimately as 1 to the ſucceſſive terms of this ſeries beginning with the leaſt. Thus, ſuppoſe the radius divided into 8 equal parts, then the ultimate ratio of the correſponding rectangles from the beginning of the quadrant will be the ratio of 1 to the terms of the following ſeries:

$$\frac{8}{16},\ \frac{7}{15},\ \frac{6}{14},\ \frac{5}{13},\ \frac{4}{12},\ \frac{3}{11},\ \frac{2}{10},\ \frac{1}{9}.$$

On ſimilar principles we may demonſtrate the following theorem in the Analyſis Equationum, &c. in a much more ſimple and elegant manner than by the method of fluxions.

Let ALE be an ellipſe, whoſe $\frac{1}{2}$ tranſverſe axis is CL, $\frac{1}{2}$ conjugate AC; let $CB=x$, $BD=y$, $AC=c$, and $CL=t$. The ultimate ratio of DG : GH, is the ratio of DB : BT, ∴ ultimately, $DG^2 : GH^2 :: y^2 : BT^2$.

$y^2 = \frac{t^2}{c^2} \times \overline{c^2 - x^2}$ from the nature of the figure;

$BT = \frac{c^2}{x} - x$, and $BT^2 = \frac{\overline{c^2 - - x^2}^{\,2}}{x^2}$.

$\because DG_2 = GH^2 \times \frac{t^2 \; x^2}{c4 - - c^2 \; x^2}$

$DH^2 = HG^2 + DG^2 = GH^2 + GH^2 \times \frac{t^2 \; x^2}{c4 - - c^2 x^2} = GH^2 \times \frac{\substack{c^4 - c^2 \\ + t^2} \, x^2}{c^4 - c^2 x^2}$

$\because DH = GH \times \frac{\sqrt{\substack{c^4 - c^2 \\ + t^2} \, x^2}}{\sqrt{c^4 - c^2 x^2}}$; that is, ſuppoſing $c = 1$, $t^2 - - c^2 = a$,

$DH = GH \times \frac{\sqrt{1 + ax^2}}{\sqrt{1 - x^2}}$: or, the moment of the arch is equal to the moment of the abſciſſe multiplied into $\frac{\sqrt{1 + ax^2}}{\sqrt{1 - x^2}}$. Wherefore a curve, whoſe ordinate is this latter quantity, increaſes in the ſame manner as the elliptical arch; and conſequently the area deſcribed by that ordinate is analogous to the length of the elliptical arch; ſo that both may be denoted by the ſame algebraical expreſſion.

Deſcription of a New Portable Barometer. By the Rev. ARTHUR M'GUIRE.

THE art of meaſuring heights by the barometer has been brought to conſiderable perfection; the mode of meaſurement is of ſingular ſimplicity. Mr. M'Guire obſerves, that mercury readily imbibes air when in contact with it, particularly if agitated; to leſſen therefore the agitation, and to diminiſh the quantity of air in contact, he propoſes that inſtead of the reſervoir being made of ſoft leather, that it ſhall be made of wood, and ſays the following conſtruction has ſucceeded beyond his expectation.

Plate XI. Fig. 5, No. 1, is a drawing of the inſtrument, or rather of what is different in this from other portable barometers.

The upper part, which is here omitted, is contrived, as is uſual in all good inſtruments of this kind, to ſhew the column of mercury with its convex ſurface againſt the light, through a groove cut intirely through the braſs tube; within this latter, and ſurrounding the glaſs tube, ſlides a ſmall one, carrying the vernier, and moved by tooth and pinion; the lower edge of this ſhews an accurate contact with the convex ſurface of the mercury at the time of obſervation.

Plate XI. Fig. 5, No. 2, is a ſection of the reſervoir and other particulars.

In No. 2, RRRR is the reſervoir formed in the turning lathe, by means of an hollowing tool introduced through the hole made for the piece L, which contains the glaſs tube I.

A is a cylindrical plug of wood, which is made to aſcend or deſcend in a hollowed cylindrical ſpace, which it very nearly fills when down; this aſcent and deſcent is effected by turning the piece M, on which is cut a ſwift ſcrew working in the piece B, which piece B is ſcrewed firmly into the box; after that the plug A is introduced and fitted into its place. G is an ivory floating gage of the uſual form.

Let us now ſuppoſe the mercury introduced into the reſervoir, with the floating gage reſting upon it, its ſurface being repreſented by the dotted line. If now the ſcrew M be turned ſo as to raiſe the plug A, the mercury will deſcend into the deſerted ſpace, and the ſurface and the floating gage reſting upon it will deſcend: Thus it appears that the piece A, as raiſed or depreſſed by the ſcrew M, is the regulator of the gage at the time of making an obſervation.

Now to fill the tube up to the top, and thereby render the inſtrument portable, you muſt proceed as follows:

By means of the crank, No. 2, turn the ſtop-cocks C and F, (No. 1 and 2) until the communication be open through them to the air, as marked in No. 2, in which you muſt conceive the ſeparated pieces lowered down, and firmly ſcrewed into their places, as repreſented in No. 1. Then the piece H, which is alſo tubular, being ſcrewed down into its place in the piece F, pour in mercury at the top T until the reſervoir be intirely filled, and continue pouring in until the mercury (having aſcended through longitudinal grooves cut for this purpoſe through the threads of the ſcrew M, parallel to its axis) appears in the piece C at S; then turn the ſtop-cock C, and all communication with the external air is cut off.

The mercury now ſtands in the tube H at the level of S; continue to pour in at T as before, and the mercury will riſe in the tube of the barometer by the preſſure of the column in H, and at length completely fill it; when this is effected, turn the ſtop-cock F, and, inverting the barometer, pour back what little remains in the tube H, which piece you may then, if you think proper, unſcrew.

The inſtrument thus filled, if carried in an inverted ſituation, is ſo free from agitation, that a ſmart trot on horſeback will not cauſe it to play ſo as to be heard or felt againſt the end of the tube.

Every part of the inſtrument is now ſuppoſed intirely filled for carriage; but when an obſervation is to be made, ſome of the mercury muſt be let out, that the remainder may deſcend to the ſtandard altitude; and for this purpoſe there is a hole at D, No. 1, ſhut by the ſtop-cock E: turn this cock with the crank, and the mercury will run out until it comes to the original level; then, having turned the cock E back again, take out the pieces C and F, and regulate the gage by the plug A, as before, and the obſervation is compleated.

This barometer, like all others, ſhould be truly vertical at the time of obſervation, and as this inſtrument ſtands upright on a table reſting on its baſe, if to this three adjuſting ſcrews are attached, and a circular level on its upper ſurface, or croſs levels, the horizontal ſtate of the box is eaſily aſcertained; but if any ſuſpicion ariſe that the tube may not be at right-angles to the top of the box, then the inſtrument may be hung in the uſual manner in gimmals.

Obſervations on Pemphigus. *By* Stephen Dickson, *M. D. &c. &c.*

OF this rare diſeaſe, ſix caſes have fallen under the obſervation of the preſent writer. Dr. Cullen (who had never ſeen an inſtance of it) has claſſed it under the *Exanthemata.* His deſcription is thus amended by Dr. Dickſon: "A fever, "accompanied with the ſucceſſive eruption from different parts of the body, inter- "nal, as well as external, of veſicles about the ſize of an almond, which become "turgid with a faintly yellowiſh ſerum, and in three or four days ſubſide." The only authors in whom he has found authentic accounts of this diſeaſe, are Carolus Piſo, Morton, Sauvage, and Dr. Stewart of Aberdeen, in Med. Comment. None of them, however, has mentioned an extraordinary peculiarity ſometimes attending it, viz. that the veſicles have occupied the internal parts of the body, and have ſucceſſively proceeded from the mouth through the whole alimentary canal. This circumſtance is illuſtrated by a caſe very diſtinctly related, which alſo gives an example of the mode of treatment in its fulleſt range. This conſiſts in obviating irritation by opiates, demulcents, and laxatives, in ſupporting the ſtrength by proper nutriment, and in guarding againſt a putrid tendency by bark and wine. Dr. Dickſon did not find the diſeaſe to be contagious, as has been repreſented, all the inſtances he ſaw having been ſolitary.

On the Extraction of the Cubic and other Roots. Communicated by the Rev. M. Young, *D. D.*

WHEN the cubic root of any number is required true to many places of decimals, let the given number be reſolved into a binomial, making the firſt term a cubic number, and the ſum or difference of the terms equal to the given number. Let both terms be then divided by the firſt, which makes the firſt term 1, and the ſecond a fraction; and let the cubic root of this reſulting binomial be reſolved into an infinite ſeries by the binomial theorem; and let as many terms of it be calculated, as give it true to two or three more than the required number of places; and laſtly, let this root be multiplied into the cubic root of the term which was made the diviſor above, and this gives the number required.

Thus:—Let it be required to find the cubic root of 28, true to ten places of decimals. Firſt make $28=27+1$, and then dividing by 27, a new binomial $1+\frac{1}{27}$ is had, whoſe cubic root is to be reſolved into an infinite ſeries. Now any power of it whatever may be found by the following ſeries,

$$1.\ \frac{m}{1.27}\cdot\frac{m-1}{2.27}\cdot\frac{m-2}{3.27}\cdot\frac{m-3}{4.27}\cdot\frac{m-4}{5.27}\cdot\frac{m-5}{6.27},\ \&c.$$

where m is the index of the power. In the preſent caſe $m=\frac{1}{3}$, and then the above ſeries reduced into numbers will ſtand thus:

$$1.\ \frac{+1}{3.27}\cdot\frac{-1}{3.27}\cdot\frac{-5}{9.27}\cdot\frac{-2}{3.27}\cdot\frac{-11}{15.27}\cdot\frac{-7}{9.27}\cdot\frac{-17}{21.27},\ \&c.$$

Each term of which ſeries being uſed as a multiplier of the laſt, reſpectively gives $\sqrt[3]{1+\frac{1}{27}} = 1,0121963239586$ which being multiplied by three, the cube root of the diviſor 27, the product will be the cubic root of 28, which is therefore 3,0365889718758.

But ſince each of theſe eight terms calculated above is imperfect, being leſs than the truth, the ſum of them may be different from the truth. Two or three of the laſt figures muſt be omitted, and then we can be ſure that the reſt are true.

If the given number had been 26, it muſt then have been reſolved into 27—1, and dividing by 27, the new binomial would have been $1-\frac{1}{27}$, and the terms of the ſeries $1.\frac{m}{3.27.}\,\frac{m-1}{3.27}$, &c. when reduced to numbers would have been $1.\frac{-1}{3.27}.\frac{+1}{3.27}.\frac{+5}{9.27}.\frac{+2}{3.27}.\frac{+11}{15.27}.\frac{+7}{9.27}.\frac{+17}{21.27}$, &c. And of the terms of the infinite ſeries reſulting, the firſt would have been affirmative, and all the reſt negative, which is always the caſe when the ſecond term of the binomial is negative, as in the following example:

Let it be required to find the cubic root of 210, true to twelve places of decimals. The neareſt cube number to 210 is 216, the cube of 6. Therefore making the binomial 216---6, and dividing by 216, the new binomial is $1-\frac{6}{216}=1-\frac{1}{36}$, and the ſeries which yields any power of it, is $1.\frac{m.-1}{1.36}.\frac{m-1.-1}{2.36}.\frac{m-2.-1}{3.36}.\frac{m-3.-1}{4.36}$, &c. Which reduced to numbers is $1.\frac{-1}{3.36}.\frac{+1}{3.36}.\frac{+5}{9.36}.\frac{+1}{9.6}.\frac{+11}{15.36}.\frac{+7}{9.36}.\frac{+17}{21.36}.\frac{+5}{6.36}$, &c. and the calculation gives 5,943,921,952,763, which is the cubic root 210 true to twelve places as was required.

The given numbers in theſe two examples, were purpoſely choſen ſuch as ſhould make the operation eaſy. But in other examples, the difference between the given number and the cube number next greater or next leſs, may be ſo great in proportion to that cube, as to make the fraction, (the ſecond member of the binomial,) too large: In theſe caſes the ſeries will converge ſo ſlowly, that the labour will be almoſt intolerable. Thus, if the given number were 13, it muſt be made equal either to 8+5, or to 27—14, and the binomial will be either $1+\frac{5}{8}$, or $1-\frac{14}{27}$. If the given number be 3, the binomial will be $1-\frac{5}{8}$; and if the given number be 2, the binomial will be $1-\frac{3}{4}$. In all theſe caſes, and ſuch like, the ſeries will converge ſo ſlowly, that a very great number of terms muſt be calculated, and therefore the labour will be immenſe. This, however, is an inconvenience that may be remedied;

for inſtead of reſolving the given number into a binomial, let it be multiplied into ſome cube number, ſo as that the product may be nearly equal to ſome other cube number.

Let the given number be 13; and a^3 will be nearly equal to $13b^3$. Call the difference y, and we ſhall have this equation, $a^3=13b^3\pm y$. We are next to find the limits of a with reſpect to b; that is, to find the multiples of b which are next leſs and next greater than a. And ſince the cubic root of 13 is between 2 and 3, $2b$ and $3b$ are the limits, of which $2b$ is nearer to a; and being leſs than a, make $a=2b+c$, and by ſubſtituting we have this equation:

$8b^3+12b^2c+6bc^2+c^3=13b^3\pm y$;
which by reduction becomes
$5b^3=12b^2c+6bc^2+c^3\mp y$. *Firſt anſwer.*

In this equation alſo we are to determine the limits of b the greater quantity with reſpect to c the leſs; which may be done by ſubſtituting ſome multiple of c for b: and according as the left ſide of the reſulting equation is leſs or greater than the right ſide, that multiple is leſs or greater than the truth. And to avoid unneceſſary trials, let the coefficient of the firſt term on the right ſide of the equation be divided by the coefficient of the term that ſtands on the left ſide; and the quotient, (neglecting the fraction,) multiplied into the leſs quantity, will be one of the limits, or near it. And when all the terms on the right ſide have affirmative ſigns, the limit thus found will be leſs than the truth; but when ſome of them have negative ſigns, it will probably be greater than the truth. Thus, in the laſt equation above, divide 12 by 5, and the quotient being 2, make $b=2c$, and upon trying it will be found, that $2c$ is leſs than the truth; therefore make $b=3c$, and upon trial $3c$ will be found greater than the truth. Therefore $2c$ and $3c$ are the limits of b, of which $3c$ ſeems nearer to the truth; therefore make $b=3c-d$, and by ſubſtituting, this equation reſults,

$8c^3=57c^2d-33ca^2+5d^3\mp y$. *Second anſwer.*

Here alſo, as before, we are to find the limits of c the greater quantity with reſpect to d the leſs; and they appear to be $6d$ and $7d$; of which $6d$ ſeems the more convenient. Making therefore $c=6d+e$, there reſults this equation,

$131d^3=213d^2e+87de^2+8e^3\pm y$. *Third anſwer.*

Here alſo the limits of d being found to be e and $2e$; and $2e$ being nearer the truth, make $d=2e-f$, and this equation reſults,

$14e^3=633e^2f-573ef^2+131f^3\pm y$. *Fourth anſwer.*

Here the limits of e are $44f$ and $45f$. Therefore making $e=44f+g$, this equation reſults,

$7831f^3=26181f^2g+1215fg^2+14g^3\mp y$. *Fifth anſwer.*

And the limits of f being $3g$ and $4g$, make $f=3g+h$, and this equation reſults,

$27851g^3=53136g^2h+44298gh^2+7831h^3\pm y$. *Sixth anſwer.*

In the ſame manner, may be found as many anſwers as any one ſhall pleaſe, and in every ſucceeding anſwer the denominator of the fraction, (the ſecond member of the binomial,) becomes greater; but the fraction itſelf, (which is ultimately ſought by this inveſtigation,) becomes leſs. Now by the help of any of the above equations marked *firſt, ſecond, third,* &c. *anſwers,* may the values of a and b be found. Thus, in any of thoſe equations make the leſs quantity $=0$ and the greater $=1$, and from theſe, by going backward, may ſucceſſively be found the values of all the letters that had been thrown off by the ſeveral ſubſtitutions, until we come to b and a; and the value of y will be the coefficient of the term on the left ſide of that equation, where the greater and leſs quantities were made $=1$ and 0. Thus, in the fourth anſwer, if we make $f=0$ and $e=1$, then will

$$\begin{aligned} d&=(2e-f=)\ 2\\ c&=(6d+e=)\ 13\\ b&=(3c-d=)\ 37\\ a&=(2b+c=)\ 87 \end{aligned}$$

Now the cube of 37 is 50653, which multiplied by 13 gives 658489, and the cube of 87 is 658503; and the difference is 14, the coefficient of the term on the left ſide of that equation: and when the ſign of y is $\pm$, as in the firſt equation, a^3 will be greater than the multiple of b^3, and therefore in the binomial, the ſign of the fractional part will be negative: But when the ſign of y is $\mp$, a^3 will be leſs, and the fractional part of the binomial will have a poſitive ſign.

By a like proceſs (*mutatis mutandis*) any root may be extracted out of a given number: but when the index of the root is any term of the duple progreſſion, beginning from unity, the operation, as is well known, may be otherwiſe performed in a more ſimple manner.

The Hiſtory of an Ovarium, wherein were found Teeth, Hair, and Bones. By JAMES CLEGHORN, *M. B.* *Communicated by* ROBERT PERCEVAL, *M. D.*

THE writer begins with ſome animadverſions on M. de Buffon, who finding ovarian conceptions difficult to be accounted for on his theory of generation, has thrown a doubt on the reality of their occurrence. He then gives a ſhort account of the caſes in which either whole fætuſes, or maſſes of hair, bones, and other ſubſtances, have been recorded as obſerved by different authors. He proceeds to the caſe which is the ſubject of the paper. A woman of 50 had borne a child about 25 years before, which ſhe nurſed. The child was attacked with violent convulſions, and from that time the mother fell into a declining ſtate of health, which continued upwards of a year; when ſhe recovered perfectly, except that her menſes never more returned, and her belly encreaſed in ſize. She remained in this ſtate 23 years, with no other inconvenience than that of her great bulk. At length ſhe was tapped, and on withdrawing the cannula, a conſiderable quantity of viſcid matter flowed out, mixed with hair and fat. She died ten days after. On opening the body, under the peritoneum was diſcovered a large ſeemingly muſcular ſac, reaching acroſs the abdomen. It was found to contain balls of a fatty ſubſtance mixed with hair, and ſeveral bones. A minute deſcription follows, of the parts of generation, illuſtrated by plates; of which this is the ſubſtance: The vagina and uterus were in a natural ſtate, as were the ovary and tube on the left ſide. The right ovary was dilated into the large cyſt that filled the abdomen, which appeared capable of holding ten or twelve quarts. The internal part of the cyſt was ſmooth in great part of its ſurface, but part was made very irregular by pouches of different ſizes, and piles of bone. The contents of the pouches were various; a gelatinous mucus, cretaceous matter, a browniſh black ſtuff like putrified bone, fatty matter, hairs, and fragments of bones. The bones were very irregular, and could not exactly be referred to any of the ſkeleton. They were all covered with a membrane reſembling the perioſteum, and over that, with a production of the internal coat of the cyſt. There were teeth, however, perfectly formed, and enchaſed in ſockets. Moſt of them might be diſtributed into the ſeveral claſſes of teeth; and while ſome appeared to be of the firſt growth, others ſeemed like thoſe of perſons of fourteen or fifteen years of age.

After this deſcription, the author touches upon two opinions maintained concerning theſe cauſes. One is that of Ruyſch, who ſuppoſes that tumours of this nature, whether in the ovarium or not, will give riſe to the growth of hair, bones, and teeth. In confirmation of which, he cites a caſe of an atheroma with theſe contents found in the body of a *young man*. Aſtruc, on the other hand, attributes them to the decay of embryos which have periſhed within the tumours; and, of courſe, makes them the conſequence of conception in females. Between theſe opinions, this writer does not decide.

POLITE LITERATURE.

An Eſſay on the Sublimity of Writing. By the Rev. Richard Stack, *D. D.*

LONGINUS, in his treatiſe on the ſublime, has laid open its five principal ſources: Boldneſs or vigour in the thoughts, enthuſiaſtic paſſion, invention of figures, ſplendid diction, and elevated compoſition. The pathetic he reſerved for a ſeparate work. A great critic, of our age and country, has endeavoured to prove that terror is the ruling paſſion of the ſublime; but he has not explained any further connection between the ſublime and pathetic, nor ſhewn in what circumſtances the paſſions can excite this principle. This Dr. Stack here attempts to do.

He lays it down, that whatever inſpires the mind with grand and lofty conceptions, is what we generally call ſublime. That all emotions that are languid are incapable of ſublime expreſſion; but if the paſſions predominate, that may not be inconſiſtent with ſublimity. The paſſion of fear, ariſing from a trifling cauſe, is the property of a weak and abject mind; but if the cauſe exceed our natural efforts to cope with, or the mind exhibit ſigns of dignity, ſuch ſubject is fitted to raiſe ſublime ideas. This paſſion appears in Macbeth, when he ſhrinks from the ſight of Macduff, whom he had injured; and in Homer, when Minerva flaſhes terror from her ægis upon the eyes of the Trojan warriors.

The object on which the paſſion is employed is alſo of conſiderable influence; whether it be great and worthy, or low and mean. The man who fears for himſelf alone, when his country is invaded, excites contempt; but the patriot alarmed and terrified, not for his own ſafety, but that of his country, preſents a ſublime object. Paſſion, therefore, though ſometimes inconſiſtent with the ſublime, at others may be highly favourable to it.

Lord Kaims concludes from induction, that dignity is not the property of any diſagreeable paſſion; this Dr. Stack cannot admit. Revenge he thinks may riſe into dignity, and if the paſſion be neceſſary for the vindication of honour, or the ſupport of any virtue, it may be employed in a ſublime compoſition. Diſdain may ſometimes lay claim to dignity. Envy and malice ſeem unſuitable to the ſublime. Grief and pity alſo, Dr. Stack thinks for the moſt part unfit. The funeral oration of Anthony over Cæſar's body, ariſing from the greatneſs of Cæſar's character, has, he thinks, ſublimity in it. The grief of Satan alſo, in Milton, has a claim to the ſublime; and the compaſſion of our Lord over Jeruſalem he acknowledges to be truly ſo.

Exceſſes, even of fear and of every other paſſion, may ſometimes be occaſions for the ſublime, as the mind then ſtrikes out great images, and pours forth ſtrong and glowing language.

Dr. Blair acknowledges the pathetic, in ſome inſtances, to be a proper ſource of the ſublime; he has not defined thoſe inſtances, but pronounces againſt Longinus's judgment on Sappho's Ode. The Doctor admits ſtrength of deſcription to be a neceſſary requiſite of the ſublime, and Dr. Stack contends, that as there are pathetic deſcriptions of certain violent affections in the ode, it is entitled to that appellation.

Another ſource of the ſublime may be laid open in the government and controul of the paſſions, which he hints as a ſubject of a future eſſay.

Dr. Stack declares his intention to be, to vindicate Longinus from Dr. Blair's ſtrictures, who aſſerts that Longinus has made a falſe diviſion of the ſubject; that of the five ſources, the three laſt have perhaps leſs relation to the ſublime than any other ſpecies of good writing. Our author thinks that Dr. Blair has miſconceived the great author's meaning. Longinus mentions the fifth ſource of ſublime as a *compoſition with ſuitable dignity and elevation*, which Dr. B. tranſlates *muſical ſtructure and arrangement.* But Longinus meant not ſuch an arrangement as pleaſes the ear, but ſupports the thought.

Nothing ſeems more calculated to produce ſublime effect than the invention and application of bold and ſtriking figures. The affected riſe of ſuch ornaments our author allows to be improper, but figurative language he thinks may be employed where the pathetic riſes to the ſublime, and is much ſurprized at Dr. Blair's rejecting this, as Longinus had exemplified its effects in more inſtances than one; as in the apoſtrophe of Demoſthenes in his oration for the crown. Dr. Stack thinks, in oppoſition to Dr. Blair, that figures are peculiarly adapted to the ſublime mode of compoſition, and inſtances two, the climax and proſopopæia.

Eſſay on the Stile of Doctor SAMUEL JOHNSON, (No. 1.) *By the Rev.* ROBERT BURROWES, *M. A.*

OBSCURITY of ſtile, Dr. Burrowes obſerves, is equally obvious and offenſive. The critic, Dr. Johnſon ſays, ſhould enquire whether he is incommoded by the author's faults or his own. That Dr. Johnſon's ſtile is obſcure is confirmed by all unlearned readers, ariſing from an affected uſe of polyſyllables of Latin derivation; yet has he criticiſed Milton's poetry as pedantic for the ſame fault, although Milton was privileged by a poetic licenſe. Dr. Johnſon has made but little uſe of this licenſe in his poetry, yet his Rambler is full of it (of this Dr. Burrowes gives many inſtances). This fault is ſtill more ridiculous when he introduces perſons writing of their own characters; yet all his correſpondents in the Rambler are infected with this literary contagion. On treating of mean ſubjects, to uſe Dr. Johnſon's own phraſe, "burleſque cannot go beyond him." Of this peculiarity of ſtile he ſeems very fond, and endeavours to juſtify it in his laſt number of the Rambler.

This fault, Dr. Burrowes contends, is committed without excuſe, when our language furniſhes a word adequate to the idea, and that many of the words uſed by Johnſon, although he ſays he can produce authorities for them, are not to be found in any Engliſh writer.

Our author endeavours to enquire into this prejudice, which he ſuppoſes to ariſe from a deſire to diſcriminate what common inaccuracy had confounded, and as familiar words admit a variety of acceptations, Johnſon ſought out theſe abſtruſe Latin derivatives which were appropriated to one ſignification excluſively; and finding that our language had for near a century been deviating towards a Gallic phraſeology, he introduced a Latin one to counteract it, in which he was well verſed.

Eſſay on the Stile of Doctor SAMUEL JOHNSON. (No. 2.) *By the Rev.* ROBERT BURROWES, *A. M.*

IN this paper Dr. Burrowes admits that every writer has his peculiarities, and as Johnſon ſtands high in public eſtimation, no one can with more advantage be made the ſubject of critical enquiry. Theſe peculiarities were not the effect of careleſsneſs or neceſſity, but ariſe from his endeavours after ſplendor or harmony.

On dignified ſubjects theſe are carefully to be attended to; but on meaner topics they ſhould be avoided. Johnſon's ſtudy of ſplendor make his ſentences ſo many detached aphoriſms. As every ſubſtantive is a word of importance, Johnſon crouded his ſentences with ſubſtantives, and he has often ſubſtituted them in place of other parts of ſpeech; thus inſtead of ſaying, " with as eaſy an approach," he writes " with the ſame facility of approach." This ambition of denoting every thing by ſubſtantives has done violence to Johnſon's conſtructions, and they often become obſcure.

Metaphorical expreſſions he has frequently employed; there his pictures are always complete, but ſometimes they return too quick and are too elaborate and too abſtruſe and ſcientific.

His peculiarities of ſtile, ariſing from the ſtudy of harmony, may be called the paralleliſm of his ſentences, which admit no clauſe without one or two concomitants, exactly ſimilar in order and conſtruction. Yet it muſt be confeſſed that ſome of his paralleliſms are ſingularly happy. His deſire of harmony has alſo led him to ſeek for even the meaneſt ornaments of alliteration, which he employs ſo frequently, that it cannot be called either caſual or involuntary. Another peculiarity of Johnſon's is a ſtudied recurrence of words in the latter part of the ſentence which had appeared in the former. Yet Johnſon may be charged with negligence; it is on the ſubject of harmony; for often ſounds almoſt ſimilar are ſuffered to approach too near each other.

Indeed all the peculiarities of Johnſon's ſtile tend to raiſe proſaic compoſition above itſelf. Dr. Burrowes concludes with remarking, that he has ſelected Johnſon's blemiſhes rather than his beauties, becauſe an eſſay may compriſe them, although whole volumes would not be ſufficient for a treatiſe on his perfections.

Thoughts on Lyric Poetry. *By* WILLIAM PRESTON.

THIS paper is written with a view to ſome remarks on an opinion of Mr. Maſon's, reſpecting Lyric Poetry, in a note on Mr. Gray's ſeventh ode, in which Mr. Maſon ſpeaks in favour of the regular, in preference to the irregular odes. In which Mr. Preſton diſſents from him, and adds an irregular ode to the moon, in which he ſays he has endeavoured to put in practice ſome of the rules laid down in his eſſay.

ANTIQUITIES.

An Account of an Ancient Inſcription in Ogam Character on the Sepulchral Monument of an Iriſh Chief, diſcovered by THEOPHILUS O'FLANAGAN, *Student of T. C. D.*

THIS monument is on a mountain called Mount Callan. Mr. Flanagan ſays, in one of the legends in verſe, inſcribed to Oſſian, he found it mentioned "that Conan was treacherouſly ſlain by the Finii of Fin, at an aſſembly met to worſhip the ſun;" and "that his name is inſcribed in Ogam characters in a flat ſtone on the very black mountains of Callan."

To ſatisfy his curioſity he went in purſuit of the monument, and by help of a cottager he found it, and made ſome attempt to decypher it; he made the inſcription to be "Beneath this ſtone is Conan the fierce, the *long-legged*;" but the true reading ſhould be the *nimble-footed.*

But on a hint from a friend, that the Phœnicians, from whom the Iriſh derived their origin, generally wrote from the right hand to the left, took the letters backward, that is, in a contrary direction from that in which we decyphered them; and after he had arranged them from left to right, not being converſant in the Iriſh language himſelf, aſked me what ſenſe would they make? I found no difficulty in anſwering his queſtion, and by this means a ſecond reading was found, which proved to be a continuation of the former ſenſe. And thus it lay determined until my arrival in Dublin, where I had an opportunity of ſtudying it ſtill more, and ſoon found the advantage of ſo doing; for upon conſulting the book of Ballimote, in the hands of Colonel Vallencey, I found there were different ſcales of the Ogam character, in each of which the number of ſimilar lines, on whatever ſide drawn, did not exceed five. Wherefore making myſelf as well acquainted with the ſcale as I poſſibly could, and again applying myſelf to the ſtudy of the inſcription, I found it read the five different ways following, viz. 1ſt. "Beneath this ſepulchral monument is laid Conan the fierce, the nimble-footed;" 2d, "Obſcure not the remains of Conan the fierce, the nimble-footed!" 3, "Long let him lie at eaſe on the brink of this lake, beneath this hieroglyphic, darling of the ſacred!" 4th, "Long let him lie at eaſe on the brink of this lake, who never ſaw his faithful clan depreſſed!" 5th, "Hail, with reverential ſorrow, the drooping heath around his lamentable tomb!" When all theſe various readings are united, there appears a rational beginning, continuation and concluſion of the ſame ſenſe. But what is ſtill farther remarkable, the number of readings is the limit of the number of lines in the Ogam ſcale. The whole is in the ſtile and manner of the ancients, deſcriptive both of the man and the place; and though the language be very ancient, yet it is equally familiar and eaſy to ſuch as are well verſed in the ſeveral idioms and dialects of the Iriſh language.

An engraving of the ſtone is given in the tranſactions.

The Antiquity of the Woollen Manufacture in Ireland, proved from a Paſſage of an ancient Florentine Poet. By the Earl of CHARLEMONT.

THE poem here alluded to is entitled Dittamondi, and written by Fazio Delli Uberti, a nobleman of Florence, which, from ſome lines in the poem, lord Charlemont ſays muſt have been compoſed about the year 1364.

The author having travelled over England and Scotland, paſſes into Ireland; the deſcription of which country he begins thus:

> " Similimente paſſamo en Irlanda,
> La qual fra noi e degna de Fama
> Per le nobile Saie che cimanda."

Which lord Charlemont tranſlates, " In like manner we paſs into Ireland, which among us is worthy of renown for the excellent ſerges that ſhe ſends us." And concludes, that from the incontrovertible teſtimony of the author, Ireland was famous for her woollen manufactory before England.

Saia is deſcribed in the dictionary Della Cruſca, as anſwering to our ſerge, and a quotation therein, from a very ancient Florentine account-book, there is a charge of a *piece of (ſaia) ſerge of Ireland*; from which he concludes, that Iriſh ſerge was among the Italians an article of dreſs; and, on further enquiry, his lordſhip ſays he finds in times very early indeed, Ireland was noted for her woollens, which were freely imported into England.

In the reign of Henry III. one man accuſes his partner in theft, for having as his ſhare a coat of Iriſh cloth. *Madox' Hiſtory of the Exchequer*, vol. i. p. 550.

By ſtatute, Edward III. cloths called frize were made in Ireland and declared free of duty.

Anno 1482, a licenſe is granted to the Pope's agents to export Iriſh woollen duty free; and by the 4th Edward IV. no cloth except of *Ireland* or Wales may be imported into England.

An Enquiry concerning the Original of the Scots in Britain. By Dr. BARNARD, *Biſhop of Killaloe.*

DR. Barnard, after cenſuring the modern hypotheſis, reſpecting the origin of the Scottiſh nation, is of opinion that a ſyſtem may be formed that will reconcile the arguments of both parties.

He admits that the Iriſh may have been the children, rather than the parents of the Caledonians, but this does not, he ſays, invalidate the hiſtory of the Mileſian Dynaſty, nor do the Iriſh chronicles record, that the whole nation derive their blood from thoſe Mileſians, but only the princes and their poſterity. The authenticity of the Iriſh genealogies, Dr. Barnard warmly contends for, nor does he think there is any thing incredible in their long duration. Granting therefore, that the ancient inhabitants of Ireland may have come from the adjacent coaſts of Britain, and not have been extirpated by the Mileſians, the intercourſe between the two countries might continue to exiſt; and a paſſage in Tacitus confirms this opinion. This intercourſe increaſed ſo much, that about the middle of the ſecond century, one Carbic Riada eſtabliſhed a ſettlement in the Weſt of Scotland. This is the firſt colony of which we have any diſtinct account in the Iriſh hiſtorians. This colony is called by the Iriſh writers Dalriadans, and by Bede, Dalrheudini, which name they changed for Scots about the year 390.

This account Dr. Barnard thinks is conſiſtent with the accounts of Ireland being peopled from Britain, and is alſo agreeable to the hypotheſis of a Mileſian ſettlement. In ſupport of this opinion, our author has made large extracts from Buchanan, John Major, and Geoffry of Monmouth; and however theſe authors may differ in leſſer circumſtances, they all agree, that a colony of Scots from Ireland had ſettled in Caledonia; that they had given umbrage to the Romans in Britain, by their hoſtilities againſt the province, in conjunction with the Iriſh, the Picts and other nations. That they were attacked by the Romans, defeated, and forced to abandon Britain. That on Maximus leaving Britain without defence, they took advantage of his abſence and made freſh attempts to reinſtate themſelves. That they were again chaſtiſed by Gratianus Municeps; but on his being aſſaſſinated, they returned in full force, with the aſſiſtance of the Iriſh and Picts, laid waſte and occupied the country from ſea to ſea (which poſſibly was no more than from the Clyde to the Forth); And laſtly, that they eſtabliſhed themſelves in Scotland about the year 396.

After this Dr. Barnard proceeds to enquire how this agrees with the Iriſh hiſtories, and thinks he has given a full confutation of the new Scottiſh Archæologia.

Ancient Gaelic Poems reſpecting the Race of the Fians.

THESE poems were collected in 1784 by Dr. J. Young, who gives tranſlations of them. Dr. Young ſays he is enabled to confute the charge againſt Mr. M'Pherſon of having fabricated the poems he publiſhed, under the name of Oſſian, as he has met with the originals of ſome of them; but acknowledges that Mr. M'Pherſon has taken great liberties with them, retrenching, adding, and altering, as he judged proper. He has alſo altered the date, and given them a higher antiquity than they are entitled to, and ſtudiouſly ſuppreſſes the mention of St. Patrick, whoſe name frequently occurs in theſe poems.

The firſt of theſe poems is called *Oſſian's Courtſhip of Everallin*; the ſecond, *The Lamentation of the Wife of Dargo*; the third, *The Combat of Con, Son of Dargo, and Gaul, Son of Morne*; fourth, *The Combat of Oſgar and Illan, Son of the King of Spain*; fifth, *The Invaſion of Ireland by Erragon*; ſixth, *The Prayer of Oſſian*; ſeventh, *The Death of Oſcar.*

Account of a Greek Manuſcript of St. Matthew's Goſpel, in the Library of Trinity College, Dublin. By the Rev. Mr. BARRETT, *F. T. C. D.*

AMONG the undeſcribed MSS. of Trinity College, there is one which is written over three other more ancient manuſcripts, one of which is found to contain a conſiderable part of St. Matthew's Goſpel. This is deſcribed in the preſent memoir, and ſome conjectures offered reſpecting its date. The writer compares it with the moſt ancient extant in the following particulars: The diviſion of the text, orthography, interpunction, and contractions. As to the firſt, this manuſcript has the ſections of Ammonius, but not the numbers of Euſebius, in which it agrees with the Teſtament of Beza at Cambridge. In orthography it perfectly agrees with the moſt ancient MSS. having the ſame permutations of vowels and diphthongs, the ſame changes, additions, and omiſſions of letters, and in the ſame manner putting the augment before the prepoſition. It alſo agrees with them in interpunction; and with reſpect to contractions, no manuſcript has ſo few.

Mr. Barrett proceeds to ſome other conſiderations for the purpoſe of drawing concluſions reſpecting its probable date. He firſt obſerves, that it is written in round and ſquare uncials, (a ſpecimen is annexed) a form belonging to the Greek MSS. of the firſt claſs, referred to the ſixth century. The figure of particular letters alſo confirms this notion of their antiquity, as likewiſe the ſimplicity of their form, and want of all modern ornament. The want of ſpirits and accents, which were firſt introduced in the MSS. of the ſeventh century, is a farther and ſtrong argument. He next notices ſome objections which may be made, which he endeavours to refute; and on the whole he concludes, that the manuſcript is not poſterior to the ſixth century. There are not wanting arguments, however, he obſerves, for a higher antiquity; and from its great agreement in the reading in many places with Beza's Teſtament, and the ſame omiſſion of the doxology, it would ſeem to have preceded the end of the fourth century.

An Account of Ancient Coins, found at Ballylinam in the Queen's County, Ireland; with Conjectures thereon. By WILLIAM BEAUFORD, *A. M. Soc. Ant. Scot.*

THESE coins were found in an urn dug up in a field by ſome peaſants, in the year 1786. They are ſmall ſilver pieces, of a very rude coinage, bearing a reſemblance of a head with a cloſe helmet on one ſide, and a croſs with ſome ornaments on the obverſe. They are all without date, but have legends in the Iriſh language, compoſed of mixed letters found in the Latin alphabets of the middle ages. Mr. Beauford is inclined to the opinion of Cambrenſis, that gold and ſilver, and money, were introduced into Ireland by the Danes; and he ſuppoſes that the Iriſh chiefs ſoon thought of ſtriking coins for themſeves, and accordingly either procured their own people to be inſtructed in the art, or hired Daniſh artificers for the purpoſe. The apparatus was very ſimple, and ſuch as might be employed by a vagrant people. From the execution of theſe coins, he concludes them to be of the earlieſt periods, from the 8th to the 12th century; and he has attempted an explanation of twelve of them, which bear the titles of the local kings or chieftains of Ireland. He adds a table a table of the ſeveral alphabets which he has uſed in the explanation, which are taken from different authors, and conſiſt of the Ogham, Ogham Croabh, Gothic, Runic, and Latin of the middle ages. Theſe, he conceives, will be ſufficient to decypher the oldeſt inſcriptions found in Great Britain and Ireland, compound letters and contractions excepted.

We have here given a ſpecimen of the Coins. See Plate XII. fig. 1.

Account of an ancient Urn found in the Pariſh of Kilranelagh, in the County of Wicklow.
By THOMAS GREEN, *Eſq.*

THIS is an earthen vaſe, nearly of the figure of an inverted cone, capable of containing 16 quarts, which was found in a flagged encloſure at the depth of ſix feet, and contained a quantity of aſhes and calcined human bones.

Tranſactions of the Royal Society of Edinburgh. Vol. II. 1790 4to.

This volume, like the former, begins with a Hiſtory of the Society, in which likewiſe an abridgement of ſeveral papers is inſerted, the firſt of which is,

A Diſſertation on Written Languages, as the Sign of Speech. By Dr. HUTTON.

AFTER conſidering the different methods of analyſing ſpeech, and ſtating the peculiar advantage of the elemental method, or that by letters, he proceeds to a ſcientifical deſcription of the formation of the alphabet.

The *vocal* power of man is diviſible into ſeven notes, of which the letter i is here affixed to the higheſt or moſt acute ſound, and u to the loweſt. In the middle is the ſound correſponding to a; and the upper half is ſubdivided into the vowels e and η; the lower into thoſe of o and υ. Theſe diſtinct vocal ſounds are compounded by means of articulations, either prefixed or ſubjoined; and thus are formed *conſonants*. Theſe are diſtinguiſhed, 1ſt, by the poſition of the organ in which they are formed; 2dly, by the operation of the breath which is employed to make them audible. The poſitions of the organ are repreſented to be five, which, with their reſpective modifications are here deſcribed. In all theſe poſitions, and in ſeveral of their modifications, there are produced two diſtinct articulators, according as the ſound is either emitted along with the articulation, or only the breath employed without any other ſound. Hence the diſtinction of mutes and conſonants. But each of theſe has a ſubdiſtinction according as the articulation of mute or conſonant is perfect or imperfect. Of theſe diſtinctions an explanation is next given; and thus a plan is laid down of a perfect natural alphabet, which might afford a ſyſtem of invariable orthography, in all languages. In writing ſpeech, there are two methods which may be purſued; the figuring ſimple ſounds, or the alphabetical method; and the figuring compound ſounds, which is the verbal. The Engliſh mode is properly alphabetical, but has deviated widely from its principles, in admitting many ſigns which are not expreſſive

expreſſive of the ſound, but of the ſenſe. This is attended with many diſadvantages, which are here ſpecified, as well as the benefits which would attend a reformation of our orthography on the true alphabetical principle.

Letter relating to the Kraken, from John Ramsay L'Amy, *Eſq.*

THIS letter was from John Ramsay L'Amy, Eſq; one of the Juſtices of the Peace for the county of Forfar, and John Guild, one of the Magiſtrates of Dundee, incloſing an affidavit made before them, of Jens Anderson, maſter, and Mads Jenson, mate of a Norwegian ſhip, relating to the appearance of a ſuppoſed kraken or ſea-worm, on Sunday Auguſt 5, 1786, about 15 leagues to the eaſtward of the coaſt of Scotland, in north latitude 56.16. The appearance was that of three low iſlands or ſand-banks of a greyiſh colour, within leſs than a mile's diſtance from the ſhip, and extending about three miles from the one extremity to the other. It remained in ſight about fifty minutes, and upon the ſpringing up of a breeze, gradually ſunk into the water. The account contains no further particulars worthy of notice, and is perfectly conſiſtent with the idea of this being nothing more than a fog-bank, of which the appearances are familiar to mariners.

Letter from the Teſhoo Lama of Thibet, to Warren Haſtings, Eſq.

AFTER returning thanks to Mr. Haſtings for having complied with a former requeſt, he proceeds; "In former ages, I repeatedly received my exiſtence "from Allahabad, Benares, Patna, Purnea, and other places in Bengal and Oriſſa; "and having ever enjoyed much happineſs from thoſe places, I have imbibed a partiality for them; and a ſincere love and affection for their inhabitants are ſtrongly "impreſſed on my heart. The well known place of Outragund gave me my laſt "exiſtence; and thanks be to God, the inhabitants of this quarter are all content "and ſatisfied with me. Where my ſpiritual eſſence will tranſmigrate to next, will "hereafter be ſeen. At preſent, here I ſit in this icy country, in obedience and "ſubjection to the Emperor of China. I have long had a deſire of ſeeing you, and "the dominions and people over whom you rule; but hitherto many cauſes have occurred to prevent me, whatever may happen in future. My travelling ſo far as your "country, to obtain a perſonal interview with you, muſt, however, be attended with "many unſurmountable difficulties, and Providence has decreed that we ſhould be at "this neceſſary diſtance from each other. From this conſideration, I am induced "to requeſt that you will grant me a piece of ground near the ſea-ſide, that I may "build a houſe of worſhip thereupon; and for the expences of building it, I have "ſent an hundred pieces of gold by Mr. Bogle, together with ſome carpets, cloths, "and other neceſſaries, which he will ſhew you, for the decoration of it; and I requeſt that you will do me the favour to let the houſe be immediately built, and the "things put up; and as ſoon as the cold ſeaſon ſets in, I will certainly diſpatch to you "ſome of my own people, if not ſome of the family of the Lama, who is patron of "the Emperor of China. I hope that you will receive them with kindneſs, and ſend

“ ſome of your own ſervants with them, to viſit every place of worſhip at Allahabad,
“ Benares, *&c.* for the diſcharge of their religious duties. As this country is
“ under the abſolute ſovereignty of the Emperor of China, who maintains an active
“ and unrelaxed control over all its affairs; and as the forming of any connection
“ or friendſhip with foreign powers is contrary to his pleaſure, it will frequently be
“ out of my power to diſpatch any meſſengers to you. However, it will be impoſſible
“ to efface the remembrance of you out of my mind; and I ſhall always pray
“ for the increaſe of your happineſs and proſperity, and, in return, I hope you will
“ frequently favour me with accounts of your health. To avoid troubling you, and
“ intruding longer upon your time with my incorrect ſtyle, I ſhall conclude this,
“ but beg you will favour me with an anſwer; and I ſhall take an opportunity of
“ addreſſing you by every perſon who goes from hence into your part of the world.
“ I have repreſented all particulars to Mr. BOGLE, who will communicate them to
“ you, and I hope you will conſent to them.”

Letter from Preſident DE VIRLY.

IT briefly relates the ſucceſs attending the exhibition of the cauſtic alkali in two calculous caſes; and notices a kind of artificial baſaltes, which he found when travelling near Sheffield, conſiſting of pieces of broken pottery uſed to mend the roads with, which broke in very regular hexagonal priſms.

Report on Mr. Hornby's Proceſs for producing an ardent Spirit from Carrots.

THE report is as follows: “ We have examined the ſample of ſpirits, which was ſent by Dr. HUNTER of York, to the Royal Society, and we have read the account of the experiment on the fermentation and diſtillation of carrots by which the ſaid ſpirit was produced. The experiment was made by Mr. THOMAS HORNBY, druggiſt, in York, with one ton and eight ſtone of carrots, which, after being expoſed to the air a few days to dry, weighed 160 ſtone, and meaſured 42 buſhels; they were waſhed, topped and tailed, by which they loſt in weight 11 ſtone, and in meaſure ſeven buſhels; being then cut, they were boiled with the proportion of 24 gallons of water to one third of the above quantity of carrots, until the whole was reduced to a tender pulp, which was done in three hours boiling. From this pulp, the juice was eaſily extracted by means of a preſs, and 200 gallons of juice were produced from the whole. This juice was boiled again with one pound of hops five hours, and then cooled to 66 of FAHRENHEIT, and ſix quarts of yeaſt being added, it was ſet to ferment. The ſtrong fermentation laſted 48 hours, during which time the heat abated to 58 of FAHRENHEIT; 12 gallons of unfermented juice, which had been reſerved, were then heated and added to the liquor, the heat of which was thus raiſed again to 66, and the fermentation was renewed for 24 hours more, the air of the brewhouſe being all this time at 46 and 44. The liquor was now turned, and continued to work three days from the bung; and, laſtly, it was diſtilled, and the firſt diſtillation was rectified next day without any addition. The produce was twelve gallons, of the ſame quality with the ſample.

" In our examination of this ſample, we found it reſembled a corn ſpirit in favour, but was equal to a corn ſpirit of the beſt kind, and it was a proof ſpirit.

" The refuſe of the carrots weighed 48 ſtone, which, added to the tops and tails, made proviſion for hogs, beſide the waſh from the ſtill, which meaſured 114 gallons.

" From this experiment, Dr. Hunter draws the following compariſon between the diſtillation of carrots and that of grain:

" 20 tons of carrots, which will make 200 gallons of proof ſpirits, may be bought for 16*l.*

" 8 quarts of malt, or rather the materials for diſtillation, conſiſting of malt, wheat and rye, may be bought for 16*l.* and will alſo make 200 gallons of proof ſpirit.

" The refuſe from the carrots will be 960 ſtone, which, at 1*d.* per ſtone, will ſell for 4*l.*

" The refuſe or grains from the malt, &c. will be 64 buſhels, each buſhel weighing about 3 ſtone, which, at 1*d.* per ſtone, will ſell for 16*s.*

" The Doctor, however, ſuppoſes, that the manufacturing of the ſpirit from carrots may be attended with more expence than the manufacturing of it from malt; but imagines that the greater value of the refuſe may compenſate for that expence, and that the ſaving of corn for other purpoſes is an object worthy of attention and of encouragement."

APPENDIX TO HISTORY.

I. *Account of Robert Dundas of Arniſton, Lord Preſident of the Court of Seſſion of Scotland.*

ROBERT DUNDAS, of Arniſton, was the deſcendant of an ancient and diſtinguiſhed family, was ſon of Robert, likewiſe preſident of the court of ſeſſion, and born July 18, 1713. After receiving the early part of his education from a private tutor, he purſued his academical ſtudies at Edinburgh. In 1733 he went to the Univerſity of Utrecht, and viſited ſeveral parts of France and the Low Countries. In 1737 he returned to Scotland, and was the next year called to the bar, where he diſplayed his diſtinguiſhed talents. In September, 1742, he was appointed ſolicitor general for Scotland, which, on the change of miniſtry in 1746, he reſigned. In that year he was elected dean of the faculty of advocates, which he enjoyed until his elevation to the bench.

Early in the year 1754 he was choſen member of parliament for the county of Edinburgh, and the next ſummer appointed king's advocate for Scotland. In parliament he oppoſed the eſtabliſhment of a militia in Scotland.

In 1760 he was appointed preſident of the court of ſeſſion in Scotland, which truſt he held twenty-five years, and diſcharged with ability, wiſdom, and rectitude. He died, December 1789, in his 75th year.

II. *Account of Sir Alexander Dick, of Preſtonfield, Bart. late Preſident of the College of Phyſicians, Edinburgh.*

HE was third ſon of Sir William Cunningham, of Caprington, by Jane, daughter of Sir James Dick of Preſtonfield, and born the 23d of Oct. 1703. His two elder brothers ſucceeded to ample fortunes, one as heir to his father, the other to his mother. Alexander made choice of the profeſſion of medicine, being inſtructed in the preliminary branches of education at Edinburgh. He went to Leyden to ſtudy phyſic under the celebrated Boerhaave, and obtained the degree of doctor of medicine in 1725, on which occaſion he publiſhed his inaugural diſſertation, *De Epilepſiâ*; and, on his return to his native country, the ſame degree was conferred on him by the Univerſity of St. Andrew's, and was admitted a fellow of the Royal College of Phyſicians, Edinburgh. Anxious to purſue his ſtudies in foreign parts he made a tour of Europe. On his return he ſettled in Pembrokeſhire, and practiſed with good ſucceſs; but his next elder brother, Sir William Dick, dying without iſſue, he ſucceeded to the eſtate and title, aſſumed the name of Dick, and then fixed his reſidence at the family ſeat of Preſtonfield, Mid Lothian, where he ſtill cultivated the ſcience of medicine, but not as a profeſſion; and in 1756, was choſen Preſident of the College of Phyſicians, Edinburgh; to which honour he was re-elected for ſeven ſucceſſive years, when he declined.

He was diſtinguiſhed as an active member of the Philoſophical Society of Edinburgh, and was enrolled one of the firſt members of the preſent Royal Society. He was alſo a vigilant manager of the Royal Infirmary of Edinburgh.

For his great care and attention to the cultivation of rhubarb in this country, the Society of Arts in London preſented him with a gold medal. In April, 1736, he married his couſin Janet Dick, by whom he has left three ſons and three daughters. He died the 18th of November, 1785; and although then in his 82d year, his judgment was unimpaired.

III. *Account of the Right Honourable Sir Thomas Miller, of Glenlee, Bart. Lord Preſident of the Court of Seſſion.*

HE was the ſecond ſon of William Miller, writer to the ſignet, and was born in 1717. After receiving his education at Glaſgow, he there acquired a reliſh for literature and ſcience. Ethics he ſtudied under the celebrated Dr. Hutchiſon. Having completed his education, he fixed at Edinburgh, and devoted himſelf to the ſtudy of the law. In 1742, he was called to the bar, where he roſe to a high degree of employment. In 1748, on the new arrangement of the office of ſheriff, he was choſen as a fit perſon for one of thoſe places; the duties of which office he performed with great punctuality, and held it till 1755, when he was appointed ſolicitor of exciſe; in 1759, ſolicitor general for Scotland; in 1760, lord advocate; and next year was choſen member of parliament for the borough of Dumfries. In this ſtation he voted againſt adminiſtration in the motion for the repeal of the American ſtamp act. In 1766, he ſucceeded lord Minto in the office of lord juſtice clerk, in which office he continued until 1788, when he was called to ſucceed the lord preſident Dundas, and had the title of baronet conferred on him. This office he did not enjoy long, but died the 27th of September, 1789, aged 72; leaving iſſue by his wife Margaret, daughter of J. Murdock of Glaſgow, one daughter and a ſon, the preſent Sir Thomas Miller.

PHYSICAL CLASS.

Of certain natural Appearances of the Ground, on the Hill of Arthur's Seat. By James Hutton, M. D.

At this place in 1776, was obſerved ſomething on the ground which reſembled the withered graſs of a foot path, which on a near inſpection appeared a narrow ſtripe of graſs quite dead, from nine to twelve inches wide, all the plants in this path being killed, without the contiguous part having ſuffered in the leaſt. The length of this track was near two hundred yards.

At firſt, thunder was conjectured to be the cauſe of this phænomenon, but difficulties occurred with reſpect to this opinion. The following obſervations were made.

1. Similar tracks were obſerved from the ſouth ſide of the ſummit, to the north ſide of the hill half way down, but none at the bottom.
2. Other tracks of this kind was obſerved parallel to theſe which appeared to have been made the year before.
3. Theſe tracks were not all contiguous.
4. Theſe tracks ran parallel and near each other.
5. Beſides the brown colour of theſe tracks, there was another ſtripe of dark green, which appeared to be graſs growing among the rotten graſs.
6. Theſe tracks are not ſtraight lines, but have more or leſs of a circular nature.

After theſe obſervations Dr. Hutton proceeds to a hiſtory of this phænomenon.

In 1777 there was a ſucceſſion of appearances. In the ſpring about the month of April, the graſs begins gradually to wither and decay. It is perfectly dead in a little time, that is, in a week or two, and then appears white or withered. Thus, every plant being killed in the new track, thoſe vegetable bodies, expoſed to heat and moiſture, gradually decay, ſo as next year to exhibit a dark or black, inſtead of a light or white track, which it had been the year before; but during the ſecond year, the dead plants are ſtill obſerved in the turf, which, as it begins to get new plants, loſes gradually the appearance of the old ones, until at laſt little more can be obſerved, than a broad ſhade of a much deeper green, which, on the one ſide, is compared with the natural verdure into which it ſometimes ſeems gradually to terminate; whereas, on the other ſide, the deep green colour of the ground formerly tracked, is contraſted with the yellow or light colour of the withered graſs.

From the inſpection of the ground, and the hiſtory of what has been obſerved to happen, nothing is more evident than that this regular ſucceſſive operation has been now repeated, at leaſt in ſome parts of the hill, for eight or nine years.

Dr. Hutton ſuggeſts many things as the cauſe of this ſtrange appearance, but does not draw any concluſion which appears to him ſatisfactory.

Fig. 1.

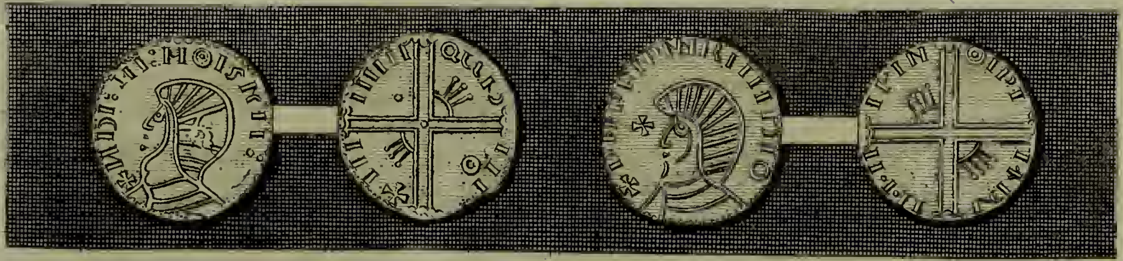
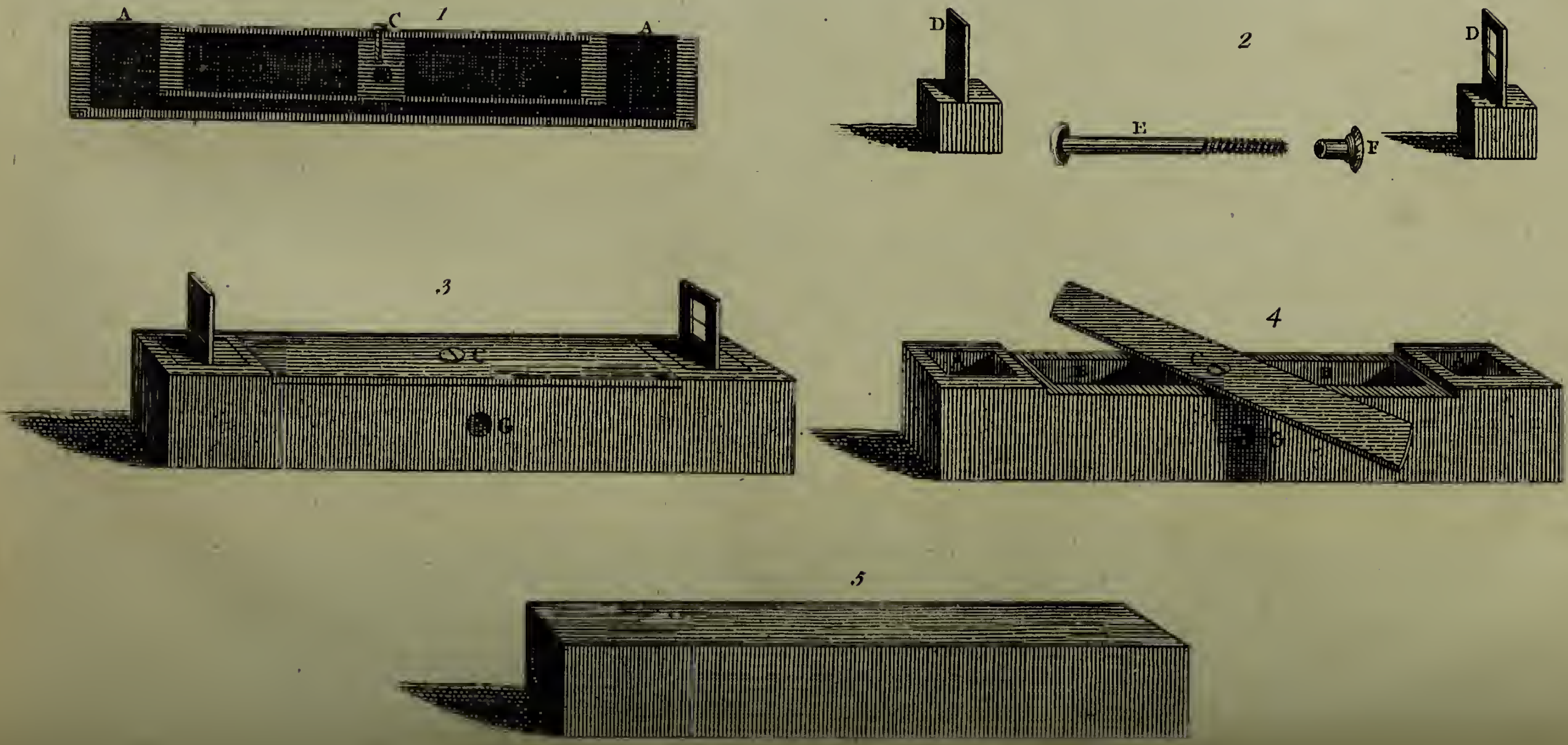


Fig. 2.



II. *Account of the Method of making Otter of Roſes.* By DONALD MONRO, *M. D.**

"I Had the following receipt for making the *Otter of Roſes,* as it is prepared in the Eaſt Indies, from Major Mackenzie of Coull, in the county of Roſs, who told me he got the account from an officer of his corps, who was up in the country where it is prepared, and aſſiſted in making it himſelf.

"Take a very large glazed earthen or ſtone jar, or a large clean wooden caſk; fill it with the leaves of the flowers of roſes, very well picked, and freed from all ſeeds and ſtalks; pour on them as much pure ſpring water as will cover them, and ſet the veſſel in the ſun in the morning at ſunriſe, and let it ſtand till the evening, when take it into the houſe for the night; expoſe it in this manner for ſix or ſeven ſucceſſive days, and, at the end of the third or fourth day, a number of particles, of a fine yellow oily matter, will float on the ſurface, which, in two or three days more, will gather into a ſcum, which is the Otter of Roſes. This is taken up by ſome cotton, tied to the end of a piece of ſtick, and ſqueezed with the finger and thumb into a ſmall phial, which is immediately well ſtopped; and this is repeated for ſome ſucceſſive evenings, or while any of this fine eſſential oil riſes to the ſurface of the water.

"*N. B.* I have been informed that ſome few drops of this eſſential oil have been more than once collected by diſtillation, in the ſame manner as the eſſential oils of other plants here in London."

III. *Deſcription of a Mercurial Level, invented by* ALEXANDER KEITH, *Eſq. F. R. S. and A. S. Edin.* See Plate XII.

FIG. 2. No. 1. is the ſection of the inſtrument formed of mahogany or box-wood. AA oblong cavities connected by a channel at the bottom, BB two grooves to contain the ſights. DD. No. 2, the two ſights, one with a ſmall hole, the other with a croſs hair, erected on pieces of ivory, or hard wood, nearly of the dimenſions of the cavities A.A. which being half filled with mercury, the ſights float on it as is repreſented in No. 3. No. 4 is a view of the inſtrument, the ſights being taken out of the lid open.

The advantages of this inſtrument are evident on the inſpection of the figures; for if the ſights are once accurately adjuſted, they will point out the true level without any further adjuſtment. It may be made of various dimenſions, ſo as to be uſed as a pocket inſtrument, and fixed to a walking ſtick. In the latter caſe it is fixed by a braſs pin E, paſſing through the hole G, and a hole in the walking ſtick, and the braſs nut F keeps them cloſe together. The grooves B.B. contain the ſights and braſs pin, and two corks covered with leather, and fitted to the holes A.A. confine the mercury.

To remedy the vibration of the ſights in a ſtrong wind, there is a caſe made of tin'd plate, or paſteboard to incloſe the inſtrument when not in uſe, No. 5. When uſed, this caſe is raiſed, leaving room for the ſights to float within the caſe, and there is an oval hole at each end, through which the obſervations are made.

IV. *Patho-*

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* As this proceſs varies from that given in the Aſiatic Reſearches, we have inſerted it.

IV. *Pathological Obſervations on the Brain.* *By Mr.* THOMAS ANDERSON, *F. R. S. Edin. &c.*

FROM ſix caſes here briefly related, the writer draws the following inferences:

1. "That when one hemiſphere of the brain is affected, it generally produces its morbid ſymptoms on the oppoſite ſide of the body."

2. "That when both hemiſpheres are affected, the whole body ſuffers."

3. "That though one hemiſphere only is affected, when the injury is great, the whole body will ſuffer."

4. "That though the cerebrum alone is hurt, it produces morbid ſymptoms in all muſcles of voluntary motion, whether their nerves take their riſe immediately from the cerebrum, from the cerebellum, or from the medulla oblongata."

5. "That, in caſes of external accident, where one ſide is affected, it is more favourable than when both ſides ſuffer."

V. *Experiments on the expanſive Force of freezing Water, made by Major* EDWARD WILLIAMS, *of the Royal Artillery at Quebec in Canada, in the Year* 1784.

MAJOR WILLIAMS being at Quebec in ſome very cold winters, determined to try the force of congelation in ſome iron bomb-ſhells, by filling the cavity of the ſhell with water, and then having plugged up the fuze-hole, expoſing it to the cold to freeze the water.

The following experiments were made on iron ſhells, from the 13 inch-ſhell to the coehorn, of 4.4 inches diameter, by filling the ſhell nearly with water, and driving in an iron plug with a ſledge hammer.

Time. 1784.	Hour.	Barom.	Ther.	Wind.	Elev. of the fuze	Wt. of plug. oz.	Diſtance.
Dec. 21.	12 night.	29.66	— 10	Weſterly.	90	35	Unknown.
22.	10 A.M.	29.69	— 3	Eaſterly.	90	37.25	22 feet.
23.	9 P. M.	29.80	— 16	W.	90	34.5	Unknown.
24	11 A.M.	29.25	— 6	W.	80	39.25	62
31.	11 A.M.	29.60	— 18	W.	45	39.25	387
1785.							
Jan. 2.	5 A.M.	29.96	— 19	W.	45	41.75	415
4.	7 A.M.	29.46	— 12	W.	45	42	Burſt.
9.	9 A.M.	29.35	— 4	W.	45	40.5	325

REMARKS.

"*Dec.* 21.—The fuze-axis of the ſhell lay nearly perpendicular to the horizon. On examining the effect, about nine o'clock the following day, I obſerved the plug gone, and a cylinder of ice, of 4½ inches high, riſing perpendicular from the fuze-hole, and of equal diameter. I ſearched carefully for the plug, but could not find it, as there was about 3½ feet of ſnow on the ground.

" 22—I watched this ſhell about an hour, when, being called out on buſineſs, I found, on my return, three hours after, the plug gone, and the icy cylinder 2¼ inches high. Plug loſt.

" 23.---I had a plug made, and jagged or notched along the ſides, to prevent its being forced out ſo eaſily; and watched this ſhell for upwards of three hours, going into the houſe at intervals to warm myſelf. The laſt time I went in was about half an hour after twelve, when, after a few minutes, I heard a ſort of hiſſing ſound, upon which running out, the plug was gone, and a cylinder of ice ſhot up, exceeding any of the former, being 6½ inches high. Plug loſt.

" 24.--- A ſimilar plug to the laſt. I watched this with more ſucceſs; for although abſent at intervals; yet at half paſt four in the afternoon, (therm. at 6°) I ſaw the plug ſuddenly forced out by the column of ice, accompanied by the hiſſing noiſe; and, obſerving its fall, I found it at 62 feet from the ſhell. The icy cylinder was four inches high, and the fuze-azis of the ſhell I found lay nearly at an angle of 80° with the horizon.

" 31.---Concluding from the foregoing experiments, that no plug could ſo be fixed, as to render the reſiſtance at the fuze-hole greater than at the weakeſt part of the ſhell, in which caſe I ſuppoſe it would burſt, (which was the primary object in theſe experiments) I thought it might be worth while to obſerve how far the force of congelation would project a plug of a given weight and figure, and forced in with the ſame number of ſtrokes of the ſledge hammer. For this purpoſe, I placed the fuze-axis of the ſhell at an angle of 45° with the horizon, and on the 31ſt of December 1784, being the coldeſt day of this year, the plug was projected whilſt I was abſent, a cylinder was ſhot out, in the direction of the axis, of 7¼ inches, and not inclining in the leaſt from that direction to the horizon. The plug was loſt.

" *Jan.* 2. 1785.---Being colder than 31ſt December, in order to haſten the effect, I put a mixture of common ſalt and ſal ammoniac to the water, and tied a long packthread, with a piece of red rag at its end, to the fuze, in order to find where it fell in the ſnow. This plug made its eſcape, like the reſt; for at half paſt ſix it was flown, and a cylinder of 8½ inches of ice ſtanding over the fuze-hole. The plug was loſt; for the red rag appeared no where on the ſurface of the ſnow.

" 4.---Tried a plug made with ſprings, in the manner of a ſearcher, only very ſhort and ſtrong. Added the freezing mixture. The ſhell gave a ſudden crack at a quarter after nine, and inſtantly ſhot from its ſurface two thin plates of ice, reſembling fins, about two inches in the higheſt parts. On examining the ſhell I found it burſt, and the plug forced up about half an inch; and, on breaking the ſhell, the ſprings were conſiderably bent, ſo as not to have recovered their firſt ſituation.

" 9.---Repeated the laſt experiment, with a ſimilar plug and the freezing mixture. It was thrown out, as before, and the projecting icy cylinder was 3¾ inches high.

" Similar experiments were afterwards made with all the leſſer ſhells; yet, though one or more of each ſort were actually burſt, more plugs were projected than produced that effect.

On theſe experiments Dr. Hutton remarks, *Firſt*, on the amazing force of the expanſion of the ice, which will overcome any reſiſtance. And

2dly, " We may hence form an eſtimate of the quantity which the water expands by freezing. For the longeſt cylinder of ice was obſerved to be $8\frac{1}{2}$ inches without the hole; to this add $1\frac{1}{2}$, the thickneſs of the metal, or length of the hole, and the ſum, or 10 inches, is the whole length of the cylinder of ice, the diameter of which is $1\frac{7}{10}$ inches; and hence its ſolid content is $1.7^2 \times 10 \times .7854$ cubic inches.

" But the diameter of the ſpherical cavity, filled with water, is $9\frac{1}{10}$ inches; and therefore $9.1^3 \times \frac{2}{3} \times .7854$ is the content of the water in cubic inches.

" Hence then the content of the water is to the increaſe by expanſion, as $\frac{2}{3}$ of 9.1^3 to 10 times 1.7^2, or as 502.4 to 28.9, or as 174 to 10. So that the water, in this inſtance, expanded in freezing by a quantity which is between the 17th and 18th part of itſelf."

VI. *Abſtract of Experiments made to determine the true Reſiſtance of the Air to the Surfaces of Bodies of various Figures, and moved through it with different Degrees of Velocity. By* Charles Hutton, *L. L. D. &c.*

THESE experiments were made with a view to perfect the theory and practice of military projectiles, and with a machine, like that deſcribed by Robins, in the firſt volume of his works publiſhed by Dr. Wilſon, conſiſting of a ſmall vertical axis, and a long horizontal arm. On the extremity of this arm a body is fixed, and a ſtrong fine ſilken thread is wound about the axis, having a ſmall weight at the end, paſſed over a vertical pulley, and left to deſcend by its own weight, and thus giving motion to the body at the end of the arm. The motion of the weight in theſe experiments was to that of the body as 1 to $57\frac{1}{7}$.

The friction of the axis and reſiſtance of the air to the arm of the body, prevent the deſcent of the weight with an accelerated velocity. For, as the reſiſtance is as the ſquare of the velocity, there will be ſoon a uniform motion; and, when this takes place, the weight is the meaſure of the reſiſtance of the air and the friction.

To find what part of the retardation is owing to the friction, and the reſiſtance of the air to the arm, both the weight of the body were taken off, and a thin bit of lead, of the ſame weight with the body, was put on the arm; various ſmaller weights were then employed at the end of the ſilk thread, till the ſame degree and uniform motion was obtained as before. This ſmall weight is then the meaſure of the friction on the axis of the reſiſtance of the air to the arm, both being made as ſmall as poſſible, the former by friction wheels, the latter by being thin and feather-edged.

The leſs weight being ſubtracted from the greater, the remainder meaſures the reſiſtance of the air againſt the body, a reduction being alſo made for the different lengths of lever, by diminiſhing the remaining weight in the ratio of the length of the arm to the radius of the axis meaſured to the middle of the thread. Thus we have a weight equal to the preſſure of the air againſt a given ſurface.

Find now a column of air equal to this remaining weight, whoſe baſe is the reſiſting ſurface, and it will have the altitude of a column, whoſe preſſure is equal to the reſiſtance.

The body uſed was a hemiſphere of paſteboard, diameter $6\frac{3}{8}$ inches, and conſequently the area of the flat ſide 32 ſquare inches, or $\frac{2}{9}$ of a ſquare foot, it weighed 4 oz. 3 dr. avoirdupois. The radius of the axis, including half the thickneſs of the thread, was 1,043 inches; the length of the arm to the center of the hemiſphere was 53,34 inches, ſo that the two radii were in the proportion of 1 : 51,14. The actuating weight muſt therefore be divided by 51,14 to reduce it to the equivalent weight, acting at the center of the hemiſphere.

To find the times of revolutions. a pendulum clock, beating ſeconds, was placed by the machine; an aſſiſtant held the hemiſphere till another, beginning at fifty ſeconds, had audibly counted the beats from 1 to 10. The firſt aſſiſtant called out every time the body paſſed him, the other called out the number of ſeconds or half ſeconds, which were inſtantly written down by Dr. Hutton. The number of revolutions was uſually about 35, the time of the firſt 25 being ſubtracted, the remainder was the mean time of ten revolutions; hence the mean time of one revolution was given, and the velocity of the hemiſphere for one ſecond of time. The actuating weights were varied by 1 dr. 2 dr. &c. and a ſeries of correſponding times and velocities obtained for the round and flat ſide moving foremoſt, and with the lead only. By ſubtracting the numbers of the latter from thoſe of the former, the remainder divided by 51,14 gave the preſſure at the center of the hemiſphere.

In the following table is an abſtract of velocities and actuating weights:

Velocity. *per* ſec.	Weights with			Diff. or true reſiſtances.		Ratios.
	Flat ſide.	Round ſide.	Lead only.	Flat.	Round.	
feet.	oz.	oz.	oz.	oz.	oz.	
3	3.8	2.2	1.2	2.6	1.0	2.60
4	6.2	3.4	1.4	4.8	2.0	2.40
5	9.2	4.9	1.7	7.5	3.2	2.35
6	12.8	6.7	2.0	10.8	4.7	2.30
7	17.0	8.7	2.3	14.7	6.4	2.30
8	21.9	11.0	2.8	19.1	8.2	2.33
9	27.6	13.5	3.3	24.3	10.2	2.38
10	34.0	16.2	3.8	30.2	12.4	2.44
11	41.0	19.2	4.4	36.6	14.8	2.47
12	48.7	22.6	5.1	43.6	17.5	2.49
13	57.1	26.4	5.8	51.3	20.6	2.49
14	66.2	30.6	6.5	59.7	24.1	2.48
15	76.0	35.1	7.2	68.8	27.9	2.47
16	86.6	40.0	7.9	78.7	32.1	2.46
17	98.2	45.3	8.7	89.5	36.6	2.45
18	111.0	51.0	9.5	101.5	41.5	2.45
19	125.0	57.2	10.3	114.7	46.9	2.45
20	140.0	64.0	11.0	129.0	53.0	2.44
1	2	3	4	5	6	7

In the laſt column are the ratio of the true reſiſtance of the flat and round ſide. Thus with velocity of 3 feet as a ſecond reſiſtance of flat is to that of round ſide, as 2,60 to 1.

It appears firſt from theſe tables, that the reſiſtance to either ſurface varies as the ſquare of the velocity nearly.

2dly. That the reſiſtance to the flat is to that on the round ſide, on an average, as 2,45 to 1, or $2\frac{4}{9}$ to 1 nearly. By the theory of the reſiſtance of fluids, this ſhould be only a ratio of 2 to 1, which may ariſe from the air differing from the fluid in the theory, and ſome ſmall part from the different figure of the hinder parts of the hemiſphere. The latter ſubject will be inveſtigated by future experiments.

3dly. That the altitude of a column of air, whoſe preſſure is equal to the reſiſtance on the round ſide of the hemiſphere, is half the height that a body muſt fall to acquire the velocity of the figure. With velocity of 10 feet in a ſecond, reſiſtance is 12,4 . $32^2 : 10^2 :: 16 : \frac{100}{64} = 1,56$ feet $=$ height from which a body falling acquires velocity 10 $\therefore \frac{1}{2}$ height is ,78. The weight is 12,4, and divided by 51,14, we have ,2411 oz. for true reſiſtance on the round ſide. A cubic foot of air weighs $1\frac{1}{4}$ oz. $\therefore 1\frac{1}{4} : ,2411 :: 1 : ,1929$, the bulk of a column of air equal to the reſiſtance, divided by $\frac{2}{9}$ of a foot, the area of the baſe, it gives ,86 foot for the height, which is about half the height found for the velocity.

4thly. That the altitude of a column of air, whoſe preſſure equals the reſiſtance on the flat ſide, is to the height fallen down to acquire the velocity of the body, as $2\frac{4}{9}$ to 2, inſtead of being equal.

END OF VOL. I.

MEMOIRS

OF

SCIENCE AND THE ARTS.

OR, AN

ABRIDGEMENT OF THE TRANSACTIONS

PUBLISHED BY

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ADDRESS to the PUBLIC.

THE Conductors of this Work are ſorry to be obliged once more to uſe the Language of Apology; but it has happened, that notwithſtanding their beſt Endeavours, it has been impoſſible for them to bring out their Numbers either with the Regularity, or to the Extent of Matter, that they propoſed. The Fact has been, that from the preſent State of the Continent of Europe, the ſcientific Purſuits of many Countries have ſuffered a Suſpenſion; and where this has not been the Caſe, Difficulties of Communication have occurred, which have produced the moſt mortifying Diſappointments in the Tranſmiſſion of foreign Publications. But they are happy to ſay, that theſe Difficulties are now in a great Meaſure ſurmounted, and that ſeveral Works of Conſequence have at Length reached them, an Abridgement of which will form the leading Articles of their next Part. And they can now venture to aſſure their Readers, that the Plan they have on mature Conſideration adopted, of two half-yearly Publications, conſtituting an annual Volume, will henceforth be ſtrictly adhered to; and that they have no Apprehenſion of again being obliged to allot ſo diſproportionate a Share to domeſtic above foreign Memoirs.

LONDON, *December* 14, 1793.

ERRATA.

Page	6,	*line*	34, *for* When *read* Whom.
——	8,	——	24, *after* reſpect *add* the.
——	9,	——	9, *after* pronounced *add a comma.*
——	9,	——	*laſt, for Siac read Siao.*
——	16,	——	25, *for* in *read* is.
——	30,	——	10, *for* is *read* was.
——	39,	——	*laſt, for* off *read* of.
——	41,	——	6, *after* Ptolemy *dele comma.*
——	43,	——	31, *for* guilty *read* guilt.
——	53,	——	29, *for* Plantarium *read* Plantarum.
——	81,	——	25, *for* warried *read* warred.
——	82,	——	38, *for* think *read* thinks.
——	82,	——	*laſt, for* cheaper *read* choſen.
——	99,	——	7, *for* form *read* from.
——	102,	——	2, *for* fand *read* ſand.
——	103,	——	6, *for* ſet *read* ſits.
——	103,	——	20, *read* Of the Empires of Bornou and Caſhna.
——	104,	——	40, *for* ſtaves *read* ſlaves.
——	106,	——	11, *after* probably *add* from.
——	177,	——	17, *for* Arunidelian *read* Arundelian.
——	184,	——	11, *for* roe *read* ore.
——	312,	——	27, *for* Ioranus *read* Soranus.
——	427,	——	36, *for* ſcletorica *read* ſclerotica.

For the explanation of the Plate II, ſee Appendix, No. I.
For references to Plate IX, Fig. 4, ſee Appendix, No. II.

MEMOIRS OF SCIENCE AND THE ARTS.

Tranſactions of the Royal Society of Edinburgh. Vol. II. 1790. 4to.

VII. *Obſervations of the Places of Herſchel, made at Edinburgh, with an Equatoreal Inſtrument. By* John Robison, *A. M. &c.*

	M. T. Edin.	Ap. Long.	Er. Th.	Ap. L. N.	Comp.
	d. h. ′ ″	s. o ′ ″	″	′ ″	
1787. Jan.	12..06..39..24	3..23..35..17	+8	32..20	4
	15..06..05..11	3..23..27..44	−7	32..20	3
	17..06..13..16	3..23..22..17	+5	32..19	2
	18..06..05..33	3..23..19..42	+2	32..21	2
	20..06..23..04	3..23..14..24	+7	32..17	4

HENCE it may be deduced, that the planet was in oppoſition January $13^{d}..04^{h}..56'$ M. T. Greenwich, in longitude $3^{s}..23^{\circ}..32'..24''$ from the mean equinox, and 30′..38″ N. L.. Hel.

The error of the theory is nearly +5″ lon. and −18″ lat. If the error was owing to the ſubſtitution of Bradley's rhombus inſtead of the micrometer uſed before, it will be diminiſhed nearly 2″.

The teleſcope has an achromatic object glaſs, 44 inches focal diſtance, magnifying power 19½, diſtinct field 92′. The planet was always compared with at leaſt two ſtars in the field, and when the poſition of the horary wire was very oblique to the horizon, and the altitudes ſmall, a correction was made for the difference in refraction.

Both ends of the polar axis were firmly ſupported in a ſtone wall, the teleſcope turning round on a pin within two inches of the upper pivot of the axis, and cloſe by the object glaſs. The other end of the teleſcope was ſupported (at the place of the wires) by a ſtiff rod turning round a pin within two inches of the lower end of the polar axis; thus the teleſcope, axis and rod formed a triangle. Another ſtiff rod was faſtened to the teleſcope at the place of the wires, with a double joint, its other end paſſing through a ſocket fixed by the window, where it was held faſt by a ſcrew-pin. The rod was in a plane, nearly parallel to the equator. By means of this inſtrument, which, excluſive of the teleſcope, did not coſt above three pounds, the image of the ſtar was kept perfectly ſteady, even in very boiſterous winds.

VIII. *Anſwer to the Objections of Mr. de Luc, with regard to the Theory of Rain.* By JAMES HUTTON, *M. D. F. R. S. Edin. and Member of the Royal Academy of Agriculture at Paris.*

THE queſtion between Mr. de Luc, and the author is this, " Whether or not, when two maſſes of air of different temperatures are mixed together, the humidity of the new maſs is greater than the mean between the humidities which the two maſſes had ſeparately." This Dr. Hutton maintains to be a phyſical truth, and Mr. de Luc refuſes to admit it as ſuch.

This laſt mentioned gentleman in his *Idées ſur la Météorologie,* examines the theory in queſtion, and endeavours to refute it by explaining in another manner, the phænomena on which the phyſical principle alluded to is founded.

In (parag. 585,) he ſays, " Je ne ſuis point ſurpris que le Dr. Hutton aît été frappé
" de ce que la reſpiration des animaux produit un brouillard dans l'air, lorſqu'il eſt humide
" ou froid; j'en ai été frappé auſſi, comme d'un phénomene qui ne s'explique pas
" par les loix ordinaires de l'évaporation: mais il m'a paru, en même tems, qu'il étoit
" d'une toute autre claſſe; qu'il n'appartenoit pas à l'hygrologie, mais à la phyſiologie;
" en un mot, que les vapeurs qui s'y manifeſtent, ne procèdent pas de l'évaporation
" d'une eau contenue dans les poumons. Ceci étant lié à quelques idées ſur la nature
" des cauſes de la pluie, j'en renvoie le dévelopement à une autre lieu, parce qu'il
" formeroit ici une trop longue digreſſion, et que d'ailleurs, ſi j'examine les faits rapportés
" par le Dr. Hutton, ce n'eſt que relativement à l'hypothèſe fondamentale
" elle même, et non à ſes conſéqeunces dans la Théorie de la Pluie; puiſqu'on a vu,
" que cette hypothèſe pourroit être admiſe, ſans que la pluie pût en être la conſequence,
" vu l'état ordinaire de l'air."

Now as all the objections as far as Dr. Hutton can obſerve, are contained in this paragraph, he propoſes to conſider it particularly, and with that view, divides it into two propoſitions. Theſe are *firſt,* a denial of the general principle, with regard to the condenſation of humidity. *2dly,* a refuſal of the application of that general principle, even if true, to the theory of rain.

It is evident that Mr. de Luc here has endeavoured to get rid of the explanation of the phænomenon, on which the theory is built, namely, the cauſe of the viſible condenſation of the breath of animals, by objecting to Dr. Hutton's ideas concerning the cauſe of evaporation, but which in reality has nothing to do with the queſtion, it being no matter in regard to that, whether evaporation is a ſolution of water in air, or a mere expanſion by means of heat. What Mr. de Luc ought to have demonſtrated was, that the condenſation of vapour was owing to a different cauſe from what Dr. Hutton alledges it to be.

With regard to the ſecond propoſition of Mr. de Luc, which is, that admitting the hypotheſis, it does not follow that rain is owing to this cauſe, the ordinary ſtate of the atmoſphere being too dry to admit of ſuch an effect. It may be anſwered to this, that rain does not in general take place in the ordinary ſtate of the atmoſphere.

Dr. Hutton next proceeds to conſider Mr. de Luc's account of the caſe of humid air, or natural vapour, where he ſays, that the appearance of the miſt above boiling water is to be explained upon other principles than thoſe laid down by Dr. Hutton, and that the mere cooling of the tranſparent ſteam as emitted from the boiling water, is of itſelf a ſufficient reaſon for its becoming condenſed and viſible. The heat which is emitted during this operation, and communicated to the air becomes the indirect means of re-evaporating the viſible miſt.

The queſtion, "ſays the author," is not, "if a body of ſteam, in the 212th degree of heat, mixed with a body of air, in the ordinary temperature of the atmoſphere, ſhould preſerve its degree of heat, that is to ſay, ſhould be cooled or not; the queſtion is, If the mean heat of this mixed maſs be ſufficient to preſerve all the humidity in a tranſparent ſtate; or, If there ſhall be formed a condenſation of viſible miſt, in this caſe as well as in the other, where moiſt and warm air was mixed with the atmoſphere? Had no condenſation in this experiment been formed, the principle of condenſation, conſequently of evaporation, could not have been extended to the caſe of ſteam, or the rule of evaporation would not have been abſolute, as comprehending both the caſe of the atmoſphere and that of water by itſelf; but the condenſation actually taking place in the experiment, generalizes this law of nature with reſpect to every poſſible combination of water, air and heat. This condenſation does not happen in conſequence of the ſteam being expoſed to any preſſure which it had not ſuſtained before, but becauſe the heat of the mixed maſs, which is the medium between the heats of the two maſſes, is not ſufficient to preſerve all the water in the ſtate of vapour; and this is preciſely what, according to the theory, the experiment is meant to prove."

With regard to the evaporation of the viſible miſt, Dr. Hutton does not think Mr. de Luc's account conſiſtent with his theory; for ſuppoſing the condenſation of the ſteam to be owing to its being cooled by the air; How could the former ſtate of things be reſtored without ſome aſſignable cauſe? This is ſuppoſing an effect without a cauſe, or a cauſe producing two oppoſite effects.

Although Dr. Hutton conſidered the phænomena of breath and ſteam, as perfectly ſufficient in themſelves to eſtabliſh the principle, with regard to aqueous condenſation, yet as they ſeemed more calculated to explain the appearance of miſt than rain, he added two other examples, of a ſhower being actually produced in a chamber.

In regard to theſe inſtances Mr. de Luc obſerves,

"Le ſeul des phénomènes cités par le Dr. Hutton, qui aît un rapport immediat avec "ſa théorie, eſt la précipitation neigeuſe des vapeurs répandues dans l'air chaud d'une "chambre, lorſque cet air vient à communiquer à un air exterieur trèsfroid. Mais "la preuve qui ſemble en réſulter en faveur de cette théorie, n'eſt qu'apparente; car "il n'y a pas lieu de préſumer, que les vapeurs fuſſent à leur *maximum* dans l'air ex"terieur ni à Tornea, ni à Peterſburg: circonſtance qui neanmoins ſeroit néceſſaire "pour produire une precipitation d'eau d'apres l'hypothèſe; à moins qu'on ne ſup"poſât encore, que quoique les vapeurs ne ſoient pas à leur *maximum* dans deux "airs qui ſe mêlent, elles peuvent le dépaſſer ſenſiblement dans le mêlange; ce qui "exigeroit toujours plus des expériences directes."

In anſwer to this, Dr. Hutton obſerves, that Mr. de Luc had no right to ſay theſe were the only examples adduced in ſupport of the theory, ſince the condenſation of the breath of animals had an immediate relation to it; and as to the objection that theſe examples of rain were more apparent than real proofs, owing as Mr. de Luc imagines, to the external air not being fully ſaturated with humidity or vapour, that very reaſon argues in favour, inſtead of againſt the theory. For if condenſation actually takes place in this unfavourable caſe, *a fortiori* it muſt be allowed in others where circumſtances are more favourable for that operation.

Mr. de Luc next endeavours to explain theſe phænomena in his way. He thinks the air of the chamber would ſoon loſe a certain quantity of its heat, and yet the external air not to be ſenſibly heated by it, and now the warm vapours ought to precipitate forming miſt in the chamber, becauſe the external air ſcarce receives any of them. Here Mr. de Luc has recourſe to the fallacious argument, of a cold body cooling a warm one without being warmed itſelf, and further is obliged to ſuppoſe that a ſhower of ſnow is produced in the warm air of a room, by the introduction of cold air, and yet that the cold and warm air do not mix, an event however, which certainly does take place, and agrees with the hypotheſis in queſtion.

Mr. de Luc, in order to put his explanation in a clearer point of view, ſays, that if the whole walls of the chamber could have been ſuddenly removed, and that the maſs of warm air had been in complete contact with the external air, there would have been at firſt a cloud formed, but which would ſoon have diſappeared in evaporation.

Whether by this ſuppoſition Mr. de Luc has greatly elucidated his explanation, Dr. Hutton leaves to more impartial judges than himſelf to determine. But he proceeds to ſhew how it can be eaſily accounted for by the principles he has laid down.

Much will depend on the degree of ſaturation or humidity ſuppoſed in the external air: a circumſtance which Mr. de Luc has omitted to mention. If not fully ſaturated, then all the appearances he has deſcribed muſt follow. If fully ſaturated, or impregnated with humidity, then in mixing with the warm air of the chamber, there is reaſon to ſuppoſe the condenſation of humidity would remain permanent, although it might not remain viſible, if ſmall in quantity and greatly diſperſed.

In the miſt which ariſes from a malt kiln for inſtance, it is evident that the vapours diſappear only in proportion as they are diſperſed in the atmoſphere; that is to ſay, as they meet with unſaturated air, by which they may be diſſolved.

This paper concludes with quoting the laſt obſervations of Mr. de Luc on the theory, and with the author's anſwer to them, both of which we give in their own words.

" Quant à l'hypothèſe que je viens d'examiner, elle étoit très naturelle dans l'état
" des faits connus; puiſqu'il n'étoit pas poſſible de concevoir d'aucune autre manière,
" que des mêlanges d'airs à differentes temperatures, puſſent produire des pluies
" abondantes: et la vraiſemblance de cette hypothèſe ne pouvoit être détruite, que
" par un genre d'experiences et d'obſervations, qui ne fait que de naître en phyſique
" avec l'hygromètre."

" In anſwer to this, I have but to obſerve, that, had Mr. de Luc contented himſelf with ſaying, as he here has done, that the probability of this hypotheſis could not be overturned, but by a ſort of phyſical experiments and obſervations which have juſt taken their birth with the hygrometer, I ſhould have waited patiently until thoſe experiments and obſervations had arrived at that maturity which might enable them to confute my theory. But Mr. de Luc has undertaken to confute it upon other principles, which do not require any profound knowledge of that inſtrument. It is only to theſe that I have anſwered: and I beg it to be underſtood, that the theory which I have endeavoured to eſtabliſh, is juſt now as open to the experiments of the hygrometer, whether for being ſupported by them or overthrown, as if nothing had been written upon the ſubject."

IX. *An*

IX. *An Account of a Diſtemper, by the common People in England vulgarly called the Mumps. By* Robert Hamilton, *M. D. Fellow of the Royal College of Phyſicians, F. R. S. Edin. and Phyſician at Lynn Regis in Norfolk.*

THIS paper was read before the Philoſophical Society of Edinburgh, in 1773.

It begins with a hiſtory of the diſeaſe, from the writer's own obſervation, from which the following pathognomic ſigns of the mumps are drawn. "The characteriſtic tumor under one or both ears, involving the ſalivary glands, with more or "leſs of a concomitant fever, is the firſt. If the diſeaſe is mild, it ſoon ends by "a ſpontaneous ſweating from the ſurface of the tumor. If not, that tumour (or "tumors, if on both ſides) ſubſides ſuddenly, accompanied with a freſh exacer"bation of fever, and the teſticles ſwell. And here it alſo ſometimes goes no fur"ther, but terminates by a diſcharge from the ſkin covering thoſe parts. But if "the teſtes ſuddenly ſubſide, and a freſh exacerbation of fever appear at the ſame "time, the brain is immediately affected, attended by a train of terrible ſymptoms, "and death ſometimes ends the conflict."

Dr. Hamilton obſerves, that the mumps is generally confined to young men from the age of puberty to thirty. He ſaw few females, and thoſe under ten years old, affected with it. It appeared at Lynn in an epidemic form in 1758, and returned ſeveral years afterwards, chiefly in the ſpring months. It prevailed greatly in 1761, but thenceforth gradually declined.

With reſpect to the treatment, it was found that the antiphlogiſtic methods with copious evacuations, often brought on the tranſlation of the diſeaſe from the ſalival glands to the teſtes and brain, with dangerous conſequences. Dr. Hamilton therefore followed the plan which nature ſeemed to point out; wrapping the parts in flannel to promote the diſcharge from behind the ears; and in caſe of the ſuppreſſion of this diſcharge, applying large bliſters to recal the diſeaſe to its proper and ſafeſt ſeat. At the ſame time, the bowels were kept gently open, and diaphoretics were adminiſtered, the effects of which were promoted by lying in bed.

It ſometimes happened, when the diſeaſe had fallen on the teſticles, that, on the ſubſidence of the tumor, one of the teſticles gradually waſted away; nothing but an empty bag of integuments remaining.

Only one caſe occurred to Dr. Hamilton which ended in ſuppuration.

In ſome inſtances, the diſorder appeared to be contagious; in others not ſo. It ſeems probable that a perſon can only have it once.

Dr. Ruſſel in his treatiſe on glandular diſeaſes, gives an account of the mumps; and Tiſſot, in his *Avis au Peuple,* deſcribes a mild ſpecies of it. It likewiſe appears to be deſcribed by Hippocrates in his *Epidemics.*

X. *A Botanical and Medical Account of the Quaſſia Simaruba, or Tree which produces the Cortex Simaruba. By* William Wright, *M. D. F. R. S. Lond. and Edin. and Phyſician-General in Jamaica.*

THE tree yielding the Simaruba bark was found in Jamaica, by Dr. Wright, to be a common inhabitant of the woodlands, and known by the names of mountain damſon, bitter damſon, and ſtave-wood. He firſt diſcovered it to belong to the genus *Quaſſia.* The cortex Simaruba is the bark of the roots. The botanical deſcription, which is illuſtrated by two plates, one of the male, the other of the female flowers (which grow on ſeparate trees) is incapable of abridgment. From the brief account of its ſenſible qualities and medical virtues we learn, that it is a pure bitter without aſtringency; that it acts chiefly as a tonic, though in large doſes it occaſions ſickneſs and vomiting; that a watery decoction is the beſt form of exhibiting it; and that the diſeaſes in which it has proved moſt efficacious, are diarrhœas and dyſenteries, immoderate hæmorrhages and other diſcharges.

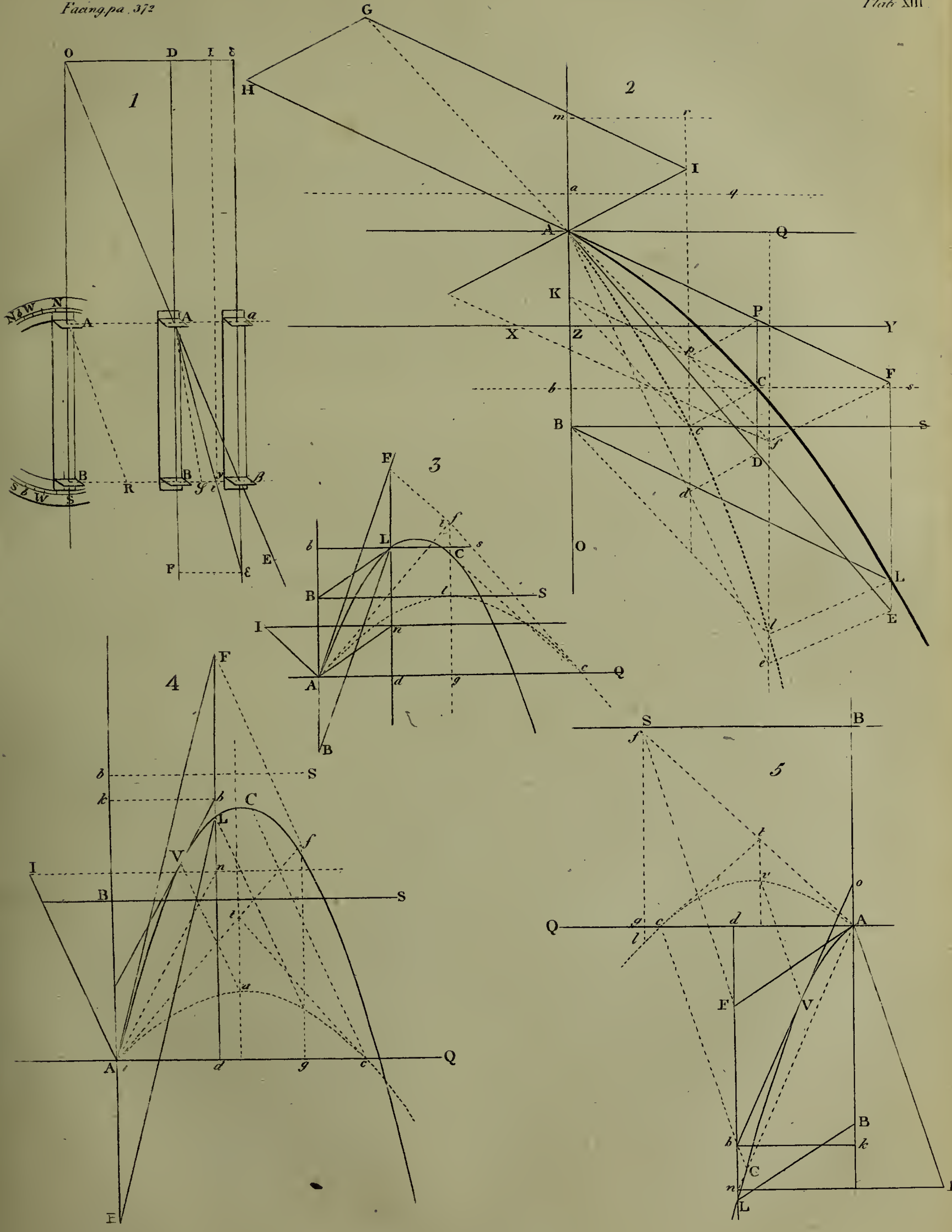
XI. *On the Motion of Light, as affected by refracting and reflecting Subſtances, which are alſo in Motion.* By John Robison, *M. A. &c.*

BOSCOVICH, whoſe works deſerve all the encomiums which this writer beſtows on them, has in his remarks on the aberration of light, made this obſervation. If a teleſcope be conſtructed having its tube filled with water, and be directed to a terreſtrial object properly ſituated, it will be found to deviate from that object by a certain determined quantity every day. It is the intention of this paper to give a ſhort account of the experiment deſcribed by Boſcovich, and of the reſult expected by him from it, to point out the overſight made by him, in ſtating the reſult, and to determine what it ought to be on his principles; and laſtly, to give the fundamental propoſition for determining the reflection and refraction of light by moving ſurfaces.

Let O, Plate XIII, Fig. 1. No. 1, a terreſtrial object be obſerved at B′, with a common theodolite in the ſtraight line O A′ B′, parallel to NS. By the motion of the earth let the obſerver be carried along the ſtraight line B′β to BO′, whilſt the object is carried with an equal motion in Oδ parallel to B′β. Then the light entering the hole A′, in direction OA′ will not paſs through the hole B, for it has changed its ſituation, and when the light arrives at B′, it has got to ſome place R in the line B′β. Make Oβ to B′β as the velocity of light, to the velocity of the earth. Through A′ draw A′Aα, parallel to B′β, cutting Oβ in A, and through A, DAB parallel to OA′B′. Let the theodolite move from A′B′ to AB, while the light moves from O to A, which from thence proceeds in direction Aβ, while B moves from B to β. The obſerver therefore ſees the object by light moving in the direction βO, though he eſtimates it in direc̄ton βα. Let BA and βα cut Oδ in D and δ; when the object is in O, D, δ, the ſights of the theodolite are at A′, A, α and B′Bβ, and the object is always ſeen in its real place. Therefore the inſtrument being kept firm in its poſition, it will always point to the object, though both inſtrument and object are changing their poſition by the motion of the earth.

If the interval between the ſights is filled with water, Boſcovich ſuppoſes, that by taking AE to Aβ in the ratio of four to three, that of ſines, incidence and refraction in air and water, when B comes to β, the light will have moved from A to E, and when the light is at β, B will be at γ, Bγ being $= \frac{3}{4}$ Bβ, therefore the obſerver will ſee an image to the right of the real object, having its angular diſtance equal to γAβ.

Hence Boſcovich concludes, that if two croſs wires were at A, and the inſtrument placed at the equator on the winter's ſolſtice, and directed to an object due ſouth, it will not appear at the interſection of the wires, but at noon will be 5″ to the eaſt of it, at ſix in the evening 5″ above, at midnight 5″ to the weſt, and at ſix in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in the morning below it, the object deſcribing a circle whoſe diameter is 10″. In other poſitions, and at other times the motion will be different, the object never appearing in its true place, except when AB is parallel to the line of the earth's motion.

If inſtead of the plane ſights of the theodolite, a common aſtronomical teleſcope filled with water ſhould be uſed, there would be no difference in the appearance, except that the object would move in a contrary direction. While the writer was endeavouring to make a teleſcope of this ſort, or to compenſate by microſcopes for the want of one, he detected an overſight in the reaſoning of Boſcovich.

Boſcovich ſuppoſes that the light entering at A deſcribes AE uniformly, while A moves to α, but from the laws of refraction it will move in the direction Aε cutting $\alpha\,\beta$ in ε, ſo that Aβ : Aε : : velocity of light in air : its velocity in water. Let Aε cut Bβ in i, at which place B will meet it, ſince the light moves uniformly along Aε, while B moves uniformly along Bβ. Therefore the obſerver will always ſee the object in its real place, and there will be no aberration in conſequence of the earth's motion.

Let O now be the real place of a fixed ſtar. It will not be ſeen at O but δ, the angle O$\beta\delta$ being equal to 20″ the ſemiaxis major of aberration. Let the water tube be uſed, and Boſcovich ſuppoſes that the ſtar will not be ſeen through it, for when B has come to β, the light has proceeded from A to E, and B is only at γ when the light is at β. Therefore to ſee the ſtar make Bφ = Aγ, and draw Aφ, which muſt be the poſition of the tube, ſince, while the light moves from A to β, the obſerver with the tube in this poſition moves from φ to β. The velocities of light in air and water being as three and four, Boſcovich makes the angle BAφ about 5″, and the aberration of the ſtar only 15′. Here is evidently the ſame overſight as in the terreſtrial aberration. Beſides, if the water tube had the poſition Aφ, the light entering A will not paſs through the other ſight, for BAβ being 20″, and BAφ 5′ the angle of incidence will be 15″, and the light will ſtill be refracted towards the perpendicular, making with it an angle ſomewhat greater than 11″.

It may be obſerved here, that ſhould there be this aberration in water tubes, which Boſcovich expects, it follows, that light is not accelerated, while refracted, towards the perpendicular, in the inverſe proportion of the ſines of incidence and refraction. But, if no ſuch thing takes place, we have a direct proof of the acceleration of light in that proportion, of its refraction being produced by forces acting perpendicularly to the ſurface, and almoſt a demonſtration, that light conſiſts of corpuſcles emitted by the ſhining body.

We come now to conſider the fundamental propoſitions reſpecting the motion of light, as affected by refracting or reflecting ſubſtances, alſo in motion.

There are two hypotheſis on the mechanical nature of light. Newton ſuppoſes, that it conſiſts of particles emitted by a luminous body, which are deflected from their courſes, by forces acting perpendicularly to the bodies which they meet. If the forces tend towards the body, the light is accelerated and refracted towards the perpendicular, if the forces act from the body, it is retarded and refracted from the perpendicular, and ſometimes reflected with its former velocity, and in an angle equal to that of incidence. This ſuppoſition is eſtabliſhed by the agreement of obſervation with the rules laid down.

The other hypotheſis is that of Huyghens and Hooke, who ſuppoſe that viſion is produced by the tremulous motion of elaſtic air, which affects the eye, as in hearing it does the ear. Euler has brought this ſuppoſition into credit, by having made ſome alterations in it. He ſuppoſes that viſion is produced by the tremulous motion of an elaſtic fluid called æther, which he ſuppoſes to pervade all bodies, and attempts to ſhew, though his reaſonings are not agreeable to the principles of mechanics, that the propagation of this tremulous motion is analogous to the appearances in the refraction and reflection of light. The velocities of incident and refracted light, are proportional to the ſeries of incidence and refraction, and conſequently light is retarded when refracted toward the perpendicular, and the particles of æther muſt be actuated by forces acting from the refracting body.

To begin firſt with an examination of the Newtonian hypotheſis, by conſidering the effect only of forces upon light, which tend toward the body, the ſame reaſoning will apply to forces acting from the medium.

Let XZY, No. 2. be a plane ſurface ſeparating two media, the denſer being the loweſt. ZA perpendicular to ZY, the greateſt diſtance of the force. Make ZB = ZA, and draw AQ, BS parallel to ZY. Call the ſpace between AQ and BS the refracting ſtratum, and ſuppoſe firſt, that the refracting forces act uniformly through the whole extent of the ſtratum.

Let the light, moving in the direction HAF, enter this ſtratum at A, while the medium is moving in direction AI. AF, AI, being ſpaces deſcribed in the time, that the refracting force would impel a particle of light from A to B. Make AO double of AB, then AF, AI, AO repreſent the velocities of the incident light, of the medium, and the velocity acquired by the particle at B, which may be called the ſpecific velocity. It is evident that in paſſing through the ſtratum, the light will deſcribe the parabola ACL, whoſe diameter is AB, tangent AF, and ordinate BL parallel to AF.

" Produce IA till Ai is equal to AI; complete the parallelogram $AFfi$, and draw the diagonal Af. The motion Af, compounded of AF, the real motion of the incident light, and Ai, the oppoſite to the motion of the medium, is the relative motion of the incident light. This motion will be uniform, becauſe it is compounded of motions which are uniform. Therefore Af will expreſs the relative velocity of the incident light. Draw FL. It is evidently equal and parallel to AB. Let CP be drawn from any point C of the parabola, parallel to AB, cutting AF in P. Complete the parallelograms $FLlf$, $flBA$. Draw Cc parallel to Ff, and make $Ff : Cc = AF : AP$. I ſay that the point c is in a parabola Acl, of which AB is a diameter, and Af a tangent, and which is the relative path of the light, and that L and l, C and c, are contemporaneous places of the light in its real and relative paths. Draw Pp parallel to Ff, cutting Af in p. Draw the ordinate CK, and draw pc, Kc. Then $Ff : Pp = AF : AP, = Ll : Cc$. But Ff is equal to Ll. Therefore Pp is equal to Cc, and pc is equal and parallel to PC and AK, and KC is equal and parallel to Ap. Therefore $Kc^2 : Bl^2 = Ap^2 : Af^2, = AP^2 : AF^2, = KC^2 : BL^2, = AK : AB$. Therefore the points A, c, l, are in a parabola, of which AB is a diameter, Af a tangent, and Kc, Bl, are ordinates. Alſo, becauſe $Ll : Cc, = Ff : Cc, = AF : AP, = T, AF : T, AP$, (by the ſymbol T, AF, &c. is expreſſed the time of moving along AF, &c.) it is evident that Cc is equal and oppoſite to the motion of the point A, while the light deſcribes the parabolic arch AC, and that Ll is equal and oppoſite to the motion of A, while the light deſcribes the arch ACL. Therefore L and *l*, C and *c*, are contemporaneous places of the real and relative paths of the light, and the parabola A*cl* is its relative path."

Suppoſe now the medium at reſt, and the light entering the refracting ſtratum at A, with the velocity, and in the direction A*f*, it muſt deſcribe the parabola A*cl*, whoſe diameter is AB, and ordinate B*l*, in the ſame time that the light incident with the velocity, and in the direction AF deſcribes the parabola ACL. Its motion therefore both before and after refraction is the ſame with the relative motion of the light, having the velocity and direction AF, incident on the medium, moving with the velocity and in the direction AI.

Let *c* be the point of interſection of the parabola A*cl* and the plane BS. Draw *c*C parallel to A*i*, cutting the parabola ACL in C. C muſt be the point of that parabola where the refraction by the moving medium is completed. For $Ll : Cc = Af : Ap, = AF : Ap, = T, AL : T, AC, = T, Al : T, cC$. Therefore, while the light moves from A to *c*, the point *c* moves from *c* to C, where the light will paſs through it, and the refraction be completed, the plane BS having now gotten into the ſituation *bs*, and the plane AQ into the ſituation *aq*.

Draw the ordinates ADE, A*de*, to the diameters PC, *pc*, and draw *mr*, the directrix of the parabola A*cl*, and join D*d*. It is known that AF is to AE as the velocity in A to the velocity in C. Now, $AE : AD = AF : AP, = Af : Ap, = Ae : Ad$. Therefore, D*d* is parallel to C*c*. Therefore the velocity A*e*, compounded of AE and E*e*, which is equal and oppoſite to AI, is the relative velocity of the light in C, and A*f*, A*e*, are the relative velocities of the incident and refracted light. Now, $Kc^2 = AK \times 4\,Am$ and $Ad^2 = cd \times 4cr, = AK \times 4cr$. Therefore $Ad^2 - Kc^2 = AK \times \overline{4cr - 4Am}, = AK \times 4AB$. Now, $Ad^2 : Ae^2 = Ap^2 : Af^2, = Kc^2 : Bl^2, = AK : AB$. Therefore, $Ae^2 - Af^2 = AB \times 4AB, = AO^2$. That is, when the light has paſſed through, and emerges from the refracting ſtratum, the difference between the ſquares of the initial and final relative velocities, is equal to the ſquare of the ſpecific velocity of the medium.

Alſo, (becauſe $Qe^2 - Qf^2 = Ae^2 - Af^2$) the difference between the ſquares of the initial and final relative perpendicular velocities, is equal to the ſquare of the ſpecific velocity.

Let the medium, the light being within it, be now ſuppoſed to move ſlowly towards the ſame, or the oppoſite quarter, and let the relative perpendicular velocity of the light be equal to the ſpecific velocity as repreſented in No. 3. By the action of the refracting forces, the parabola ALC would be deſcribed, of which $AB' = AB$, is an abſciſſa and $B'L = AF$ an ordinate. Draw I*n* parallel to AQ, cutting FL in *n*. *dn* is the perpendicular velocity of the medium, *d*F that of the incident light, and *n*F its relative perpendicular velocity, = by ſuppoſition $2.\,A'B$. $FL = AB \therefore Ln = AB$, and A*n* is an ordinate to FL and LB is a tangent at L, and *b*L*s* is the ſituation of the plane BS, when the light entering at A is at L. BL is the velocity of the light at L, and B*b* its perpendicular velocity = *dn*, the perpendicular velocity of the medium. As they have the ſame velocity in the direction LF, the light will not paſs through the plane *b*L, but be deflected towards AQ, deſcribing another arch LC of the parabola, and will be met in C by the point *c* of the plane AQ, which has moved in the mean time through C*c* parallel to IL. *l* is the vertex of the relative path A*lc*, *lg* the abſciſſa $= BA \therefore fg$ the relative perpendicular velocity $= 2.\,AB$, or the ſpecific velocity.

In No. 4, the relative perpendicular velocity of the light is ſuppoſed leſs than the ſpecific velocity, and conſequently it will not paſs through the whole refracting ſtratum. In No. 5, the light within the medium moves from the refracting ſurface, and is overtaken by it.

In the caſes of reflection, No. 3, 4, 5, the angle of relative reflection = the angle of relative incidence, and the relative velocities are alſo the ſame. For A*t*, *tc* repreſenting the velocities, are equal, and equally inclined to the axis of the parabola A*lc*.

Suppoſing the refracting ſtratum to be divided into ſeveral parallel ſtrata, the relative motion of the light emerging from the firſt ſtratum, is the relative motion of the light immerging into the ſecond ſtratum, and the relative motion of light emerging from the ſecond ſtratum, is the ſame as if the medium had been at reſt, and the light had approached it with the ſame relative initial motion. The ſame holds with reſpect to the other ſtrata, and to the final motion of the refracted light.

Alſo the change made on the ſquare of the relative velocity of the incident light, paſſing through the refracting ſtratum, is equal to the ſquare of the velocity a particle of light would acquire, if impelled by the variable refracting forces from a ſtate of reſt through the whole ſtratum. Suppoſing the medium at reſt, and light approaching it with the ſame relative motion, the abſolute velocity of the light entering one of the ſtrata, is the ſame with its relative velocity on entering the medium in motion. But the change in the ſquare of the abſolute velocity is equal to the ſquare of the ſpecific velocity of that ſtratum. Let the velocity of light entering this ſtratum equal that acquired, if impelled by the refracting forces from a ſtate of reſt at A, the change made on the ſquare of this velocity would have been ſtill the ſame, and the whole velocity would be that acquired by the varied impulſe from a ſtate of reſt in A. This is true of the laſt ſtratum; therefore the change made in the ſquare of the velocity of light that has paſſed through all the ſtrata, is equal to the ſum of the ſquares of their reſpective ſpecific velocities, or the ſquare of the ſpecific velocity of the whole refracting ſtratum. The abſolute velocity of the light emerging from the refracting ſtratum of the quieſcent medium, being the ſame with its relative velocity on emerging from the refracting ſtratum in motion, the change made on the ſquare of the relative velocity of the incident light is equal to the ſquare of the ſpecific velocity of the medium.

Let the thickneſs of the ſtrata be diminiſhed without end, and the refracting ſubſtances in motion may act on the light with forces continually varying according to any law of the diſtances, and this may be conſidered as a fundamental propoſition, that,

If a ray of light, moving in any direction, and with any velocity, meet with the ſurface of a refracting medium in motion, its final relative motion will be the ſame as if the medium had been at reſt, and the light had approached it with the ſame initial relative motion.*

Cor.

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* The following demonſtration is by Profeſſor Playfair. Let v be the velocity of a particle of light when it has arrived at the diſtance x within the refracting medium (x being counted from the point in which the particle began to be acted on, and being leſs than the diſtance from that point at which the motion of the particle again becomes uniform.) Let f be the force acting on the particle at the diſtance x. Let a be the velocity of the incident light, and c the velocity of the medium in the oppoſite direction.

It

Cor. 1. The relative velocities of the incident and refracted light are as the coſecants of the relative angles of incidence and refraction. For they are as A*f*, A*e* (No. 2,) which, if AQ is made a radius are the coſecants of BA*f*, BA*e*.

Cor. 2. The relative velocity of incident light being the ſame in all the relative angles of incidence, the relative velocities of refracted light will be equal in all the relative angles of refraction. For the ſum or difference of the ſquare of the relative velocity of incident light, and the ſquare of the ſpecific velocity, both being conſtant, make the ſquare of the relative velocity of refracted light, to which they are equal, alſo conſtant.

Cor. 3. Hence the ſines of relative incidence and refraction are in a conſtant ratio.

Cor. 4. Light moving in a medium A, and refracted by a medium B in motion, and emerging from it into the medium A, will regain the relative velocity, which it had firſt in this medium.

Cor. 5. If the relative paths of light, before it enters the medium B, and after its emergence from it, be equally inclined to the direction of the medium, the abſolute velocities of the incident and emergent light, will in that, but no other caſe be equal. Therefore in approaching to, or receding from a fixed ſtar, the abſolute velocity of its rays, emerging from the plane ſurface of a plane convex lens, will be increaſed or diminiſhed.

To apply the above to the experiment of Boſcovich. Suppoſe the water tube (No. 1,) in poſition AB, the relative motion of light in the teleſcope is the ſame as
if

It is evident that the force f does not act on the particle during its paſſage through the whole ſpace $\dot{x}$, but only during its paſſage through the part $\frac{v}{v+c}\dot{x}$. Therefore, $v^2 = a^2 + 2\int\frac{f v \dot{x}}{v+c}$, and $2v\dot{v} = \frac{2vf\dot{x}}{v+c}$, or $2\dot{v} = \frac{2f\dot{x}}{v+c}$. That is, $2v\dot{v} + 2c\dot{v} = 2f\dot{x}$, and, taking the fluent, $v^2 + 2cv = 2\int f\dot{x} + C^2$. But when $2\int f\dot{x} = 0$, we have $v^2 + 2cv = a^2 + 2ac$, and therefore $v^2 + 2cv = a^2 + 2ac + 2\int f\dot{x}$. Let the fluent of $2f\dot{x}$ (aſſumed, ſo that x ſhall be the diſtance at which the velocity of the light again becomes uniform) be ſuppoſed $= g^2$. Then $v^2 + 2cv = a^2 + 2ac + g^2$. Add c^2 to both ſides of the equation. Then $v^2 + 2vc + c^2 = a^2 + 2ac + c^2 + g^2$; and therefore $\overline{v+c}^2 = \overline{a+c}^2 + g^2$. But $a+c$ is the relative velocity of the incident light, and $v+c$ is the relative velocity of the refracted or accelerated light. Therefore the ſquare of the latter exceeds the ſquare of the former by the conſtant quantity g^2. Now, $g^2 = 2\int f\dot{x}$; and is therefore (by the celebrated 39th propoſition of the firſt book of the Principia) the ſquare of the velocity which a particle of light would acquire if impelled from a ſtate of reſt through the whole diſtance at which the medium acts on light.

“ Since the relative velocities, eſtimated in a direction parallel to the refracting ſurface, are not changed by the action of the refracting forces, it evidently follows from this demonſtration, that the difference between the ſquares of the relative velocities of the incident and refracted light, is equal to the ſquare of the ſpecific velocity of the medium, whatever may be the directions of the incident and refracted light, and therefore, that the final relative motion of the refracted light is the ſame as if the medium had been at reſt, and the light had approached it with the ſame relative motion. But although this demonſtration would have been much more elegant, and more agreeable to the manner in which I have been accuſtomed to explain the refraction of light, I choſe to retain the demonſtration which I have given in the text, becauſe I think that it gives me a better opportunity of exhibiting to the mind the whole motion of the light during its refraction or reflection. At the ſame time, I thought it my duty to communicate, with Mr. Playfair's permiſſion, his demonſtration to the public.”

if the teleſcope had been at reſt, and the light approached it with the ſame relative motion. DA is the relative motion of the light. If therefore the teleſcope had been at reſt, and the light had entered it in the direction, and with the velocity DA, it would have proceeded in the direction AB, and the teleſcope muſt always be directed to the real place of the tereſtrial object.

XII. *Demonſtrations of ſome of Dr. Matthew Stewart's General Theorems.* *By* Robert Small, *D. D. F. R. S. Edin.*

THESE are demonſtrations of theorems VI. VII. VIII. IX. X. XI. XII. XIII. XIV. XVI. XXVII. XXVIII. The writer propoſes to give hereafter the demonſtrations of the theorems, reſpecting the cubes and other higher powers. This moſt probably will lead him to publiſh the demonſtrations of all the propoſitions, and thus to make Stewart's work complete.

XIII. *Remarks on the Aſtronomy of the Brahmins.* *By* John Playfair, *A. M. &c.*

FROM the aſtronomical tables of the Brahmins, brought into Europe in 1687, by La Loubere, from Siam, and two other ſets ſent to Paris by the miſſionaries in Hindoſtan, and one brought by Le Gentil, with the explanations given of them by Le Gentil and Bailly, theſe remarks are drawn up, and directed to three different points. The firſt is, to give a ſhort account of the Indian aſtronomy, ſo far as it is known to us from the four ſets of tables above-mentioned: the ſecond, to ſtate the principal arguments that can be deduced from theſe tables with reſpect to their antiquity: and the third, to form ſome eſtimate of the geometrical ſkill, with which this aſtronomical ſyſtem is conſtructed.

The aſtronomy of India not giving any theory, or even deſcription of the celeſtial phænomena, is confined to the calculation of certain changes in the heavens, particularly of the eclipſes of the ſun and moon, and to the rules and tables, by which theſe calculations muſt be performed. With ſcarce any knowledge of the principles the Brahmin obtains his reſult, and is perfectly ſatisfied, if the commencement or duration of the eclipſe anſwers within a few minutes to his predictions, and his obſervations extend no farther than to determine the meridian line, or the length of the day at the place where he obſerves.

The objects therefore of this aſtronomy are principally three, 1. Tables and rules for calculating the places of the ſun and moon: 2. Tables of rules for calculating the places of the planets: 3. Rules by which the phaſes of eclipſes are determined.

The Brahmins, from the moon completing her revolution in nearly twenty ſeven days, have divided their zodiac into twenty ſeven equal parts. To the phaſes of the moon, the common diviſion into weeks is to be aſcribed, and it is remarkable, that the days of the week are dedicated by the Brahmins, as by us, to the ſeven planets, and preciſely in the ſame order.

Theſe twenty ſeven parts are diſtinguiſhed by ſmall groupes of ſtars. The firſt of them conſiſting of ſix ſtars extends from the head of Aries, to the foot of Andromeda in our zodiac, and occupies a ſpace of about ten degrees in longitude. The ecliptic is however divided, as with us, into twelve equal ſigns, with names and emblems of ſimilar import, a diviſion which muſt have been the reſult of ſome ancient and unknown communication. The ſigns are divided into thirty degrees, and each degree into 60′ and ſo on. Their day is divided into ſixty hours, the hours into ſixty minutes, and ſo on.

The preceſſion of the equinoxes is known to the Brahmins, and its motion is computed at the rate of 54″ annually, being too great by ſomewhat leſs than 4″ a year. In determining the ſame quantity Ptolemy committed an error of 14″. The longitude of the ſun and moon is expreſſed by their diſtance from the beginning of the moveable zodiac.

Theſe remarks belong to all the tables. Each has its peculiarity. To begin firſt with thoſe of Siam.

To calculate the place of any of the celeſtial bodies for a given time, three things are requiſite. 1ſt. To aſcertain the poſition of the body in ſome paſt inſtant of time, which is called the epoch of the tables. 2. To aſcertain the mean rate of the planet's motion from whence its mean place is diſcovered. 3. To aſcertain the correction neceſſary to diſcover by addition or ſubtraction, the true place of the planet. This correction when it ariſes from the eccentricity of the orbit is called the equation of the centre.

The epoch correſponds to the 21ſt of March, in the year 638 of our era, at three in the morning, on the meridian of Siam, at which time the ſun and moon entered the moveable zodiac. From this epoch the mean place of the ſun is deduced, on the ſuppoſition that in 800 years, there are 292207 days. Hence the ſydereal year conſiſts of 365*d*..6*h*..12′..36″. By taking away 21′..55″, or the time the ſun takes to move over 54″, there remain 365*d*..5*h*..50′..41″ for the length of the tropical year, exceeding that of De la Caille, by only 1′..53″.

The greateſt equation of the ſun's centre is 2°..12′, about 16′ greater than that determined by the modern European aſtronomy. This is not to be aſcribed wholly to error, as there was a time when the equation was of this magnitude. For other places, the equation varies as the ſine of the mean diſtance from the apogee, nearly as in our tables. The apogee is 80° beyond the beginning of the zodiac, and is ſuppoſed to retain always the ſame poſition among the fixed ſtars. This ſuppoſition is nearer the truth than that of Ptolemy, which makes the apogee at reſt, and conſequently regreſſive among the fixed ſtars, by the whole quantity of the preceſſion of the equinoxes.

The motions of the moon are deduced by certain intercalations from a period of nineteen years, in which ſhe makes 235 revolutions. Her apogee was in the beginning of the moveable zodiac 621 days after the epoch above-mentioned, and makes a revolution in 3232 days. The firſt ſuppoſition agrees within a degree to the tables of Mayer, the latter differs only from them by 11*h*..14′..31″.

The greateſt equation of the moon's centre, when its mean diſtance from the apogee is 90°, is 4°..56′, being only 2′ leſs than that in Mayer's tables, in other ſituations the equation varies as the ſine of the diſtance from the apogee.

The Siameſe MS breaks off here. Caſſini obſerves, that the tables are not conſtructed for the meridian of Siam, becauſe the rules direct 3′ to be taken away for the ſun, and 40′ for the moon (being the motion of each for 1*h*..13′) from their longitudes, calculated as above. The meridian of the tables is therefore 1*h*..13′ or 18°..15′ weſt of Siam, which brings us near to the meridian of Benares. Hence we may conclude, that the tables of Siam came originally from Hindoſtan.

In the ſet now in the poſſeſſion of the Academy of Sciences, ſent about 1750 by Du Camp from Chriſnabouram in the Carnatic, to De Liſle, there are fifteen tables, including, beſides the mean motions of the ſun, moon and planets, the equations to the centres of the ſun and moon, and two corrections for each of the planets, one correſponding to its apparent, the other to its real inequality. The epoch is at ſun riſe on the 10th of March, 1491, the ſun in conjunction with the moon entering the moveable zodiac, two circumſtances by which almoſt all the Indian eras are diſtinguiſhed. Theſe places agree very well with the calculations made from the tables of Mayer and De la Caille. In the mean motions they differ, but doing ſo equally for the ſun and moon, they produce no error in determining the relative poſition of theſe bodies. The ſun's apogee has a motion ſwifter than that of the fixed ſtars by about 1″ in nine years. The equation of its centre is 2°..10′..30″. The equation of the moon's centre is 5°..2′..47″; the angle between the paths of the ſun and moon is 4°..30′, and the motions of the apogee and node are very near to the truth.

Father Patonillet ſent about the ſame time, another ſet of tables to De Liſle, which very much reſemble theſe of Chriſnabouram. From the rule for determining the length of day, which anſwers to latitude 16°..16′, Bailly ſuppoſes them to come from Narſapour. The epoch is between the 17th and 18th of March, 1569, at midnight. In computing the places of the ſun and moon, a correction is uſed ſimilar to that of the moon's motion which Tycho diſcovered, and called the annual equation, its quantity depending on the ſun's place in the ecliptic, and being proportional to the inequality of the ſun's motion, and nearly a tenth part of it. In theſe tables the annual equation is only $\frac{1}{27}$ of the ſun's, and they make another error in adding it to, inſtead of ſubtracting it from the moon's longitude. This inequality in the lunar motions not being found in any ſyſtem, with which the Indian aſtronomers can have had a communication, is a proof of the originality of the tables.

The tables and methods of the Brahmins of Tirvalore have ſtill greater ſingularities. The ſolar year is divided into twelve unequal months, each being equal to the time of the ſun's paſſage through one ſign. Any, or June, when the ſun is in the third ſign, conſiſts of 31*d*..36*h*..38′, and Margagy, or December, when he is the ninth ſign, conſiſts of 29*d*..20*h*..53′. The ſun's apogee is 77° from the beginning of the zodiac, and the equation of his centre about 2°..10′. In calculating, the aſtronomical day is uſed, being the time of the ſun's paſſage through one degree of the ecliptic.

The epoch coincides with the famous era of Calyougham, that is, with the beginning of the year 3102 before Chriſt. To find the ſun's place for a given time, they multiply the years from that epoch by 365*d*..6*h*..12′..30″, and take away 2*d*..3*h*..32′..30″, the aſtronomical epoch having begun ſo much later than the civil. They then find the number of days elapſed from the beginning of the current year, and reduce them into aſtronomical months, days, &c. which conſequently give the ſun's longitude.

The rule to find the moon's place is more artificial. 1600894 days after the epoch, the moon was in her apogee diſtant 7*s*..2°..0′..7″, from the beginning of the zodiac. 12372 days after ſhe was again in apogee, with 9*s*..27°..48′..10′ more of longitude, again in 3031 days more with 11*s*..7°..31′..1′ more of longitude, and 248 days after, again in apogee with 27°..44′..6″ more of longitude. Hence they find, how far ſhe is advanced in this period of 248 days, and from a table expreſſing the time of her paſſage through each degree of her orbit, they find her place in the zodiac.

The moſt material difference in theſe from the other tables, is in the antiquity of their epoch. Whether this is real or fictitions may be diſcovered from the following conſiderations.

At the time of the epoch, the beginning of their moveable zodiac, was 54° before the vernal equinox, or in longitude 10*s*..6° according to our method. From the Indian zodiac, brought by Le Gentil, it appears, that Aldebaran is 53° 20′ from the beginning of the zodiac; at the epoch it was therefore 40′ from the vernal equinox. Its longitudes in 1750, by the beſt modern obſervations, was 2*s*..6°..17′..47″, and ſuppoſing it to have gone forward at the preſent rate of the preceſſion of the equinoxes 50′ ⅓ annually, it muſt have been at the epoch 1° 32′ before the equinox. Add De la Grange's correction of 1°..45′..22″ for the inequality in the preceſſion, and its longitude will be 13′ before the equinox, agreeing within 53′ with the Indian aſtronomy. As the Brahmins make the motion of the fixed ſtars too great by more than 3″ annually, if they had calculated backward from 1491, Aldebaran would have been placed leſs advanced at the epoch by 4° or 5°. Hence it is probable that the Indian zodiac is as old as the epoch.

Bailly, from comparing the tables of Tirvalore with thoſe of Chriſnabouram, ſuppoſes the ſun's true, not his mean place at the epoch, to have been in longitude 10*s*..6°. Therefore his mean place was in 10*s*..3°..38′..13″. By De la Caille's tables, and ſuppoſing the preceſſion of the equinoxes 50″ ⅓, the mean longitude is 10*s*..1°..5′..57″. Adding De la Grange's correction 1°..45′..22″, the mean longitude is 10*s*..2°..51′..19″, differing not more than 47′ from the tables of Tirvalore. Too great a ſtreſs muſt not be laid on this argument, as it is not yet certain that the ſun is to be conſidered in his true place at the epoch.

The moon's mean place calculated by Mayer's tables, on a ſuppoſition that her motion has always been the ſame as at the beginning of this century, is at the epoch in 10*s*..0°..51′..16″. But as her angular motion in one age is according to Mayer 9″ greater than in the preceding, in 4801 years there muſt have been an acceleration, amounting to 5°..45′..44″. By adding this to the preceding, the real mean place is 10*s*..6°..37′, only differing 37′ from the tables of Tirvalore, which could not therefore have been made but from actual obſervation.

That the aſtronomy of the Brahmins is not derived from that of the Greeks, Arabians, Perſians, or Tartars, is evident from the compariſon made by Bailly between them. By the tables of Ptolemy, the longitude of the ſun at the epoch is 10°..21′..15″, and that of the moon 11°..52′..7″ greater than thoſe in the Indian tables. They differ from the tables of Ulugh Beig in the place of the ſun 1°..30′, and in that of the moon 6°.

But to return to the moon's acceleration. The tables of Tirvalore, if their antiquity is properly determined, ought to make the moon's mean motion much ſlower than at preſent. Her motion for 4383 years 94 days from the epoch, is 7*s*..2°..0′..7″ or 9*s*..7°..45′..1″ from the vernal equinox. By the tables of Mayer, it is greater by 2°..42′..4″, a quantity far ſhort of that aſſigned by Mayer to the acceleration. By the tables of Chriſnabouram, the motion in the ſame time is 3°..2′..10′ leſs than in thoſe of Tirvalore. Hence we may conclude with Bailly, that the former are more ancient than the latter tables, and the tables of Chriſnabouram make the moon's motion leſs than Mayer's by 5°..44′..14′, which is therefore their quantity of acceleration. This acceleration on Mayer's principles, that is, by calculating how much the angular motion of the moon muſt have been leſs, if her velocity had all that time been uniformly the ſame as in the preſent century, is 5°..43′..7″, that is, only 1′..7″ leſs than that by the tables of Chriſnabouram. Hence we may infer, that one ſet of tables is not leſs ancient than the Calyougham, and the other cannot be later than 2000 years before the Chriſtian era.

This coincidence between the aſtronomy of India and Europe, founded on the moon's acceleration, is very remarkable. De la Place has proved that it is indirectly produced by the action of the planets on the earth, by which its eccentricity is alternately increaſed or diminiſhed, and the diſturbing forces on the moon are rendered more variable. In a courſe of ages the moon's motion will be as much retarded as accelerated, but from the ſlowneſs of its changes, her motion has been conſtantly accelerated for a longer period than that to which the obſervations of India extend.

By the formula given by De la Place, the acceleration for 4383 years from the beginning of the Calyougham, is greater by 17′..39″ than that by Mayer's rule, and conſequently greater by 16′..32″ than that deduced from the tables of Chriſnabouram. This coincidence is ſtill ſufficient to afford a ſtrong confirmation of the accuracy of the theory, and the authenticity of the tables: and thus obſervations made in India, when Europe was in a ſtate of barbariſm, are confirmed by inveſtigations into the effects of gravitation five thouſand years after in Europe, and afford the moſt ſtriking example of the progreſs and viciſſitude of ſcience, which the hiſtory of mankind has yet exhibited.

In the tables of Tirvalore, the tropical year conſiſts of 365*d*..5*h*..50′..35″, being 1′..46″ longer than that of De la Caille. From the theorem of De la Grange, on the variation of the length of the tropical year, it appears that the year 3102 before Chriſt, was 40″½ longer than the year at the beginning of the preſent century. The year therefore in the tables is too great by 1′..5″½. But if we ſuppoſe theſe obſervations to have been made in the period of 2400 years immediately preceding the Calyougham, to which the Brahmins often refer, and that the inequality of the preceſſion of the equinoxes increaſes as we go back, as the ſquare of the times, the length of the year 1200 years before the Calyougham, was 365*d*..5*h*..50′..41″ nearly as in the tables. Hence the determination of the ſolar year was made 4300 years before the Chriſtian era.

This argument cannot however be relied on, as we are not at liberty to ſuppoſe, that the preceſſion of the equinoxes increaſes in the above mentioned ratio. By De la Grange's formula it appears, that the ſolar year was longer at the beginning of the Calyougham than it has ever been ſince, or than it had been for many ages before. It was then 40″½ longer than at preſent: 5500 years before Chriſt it was only 29″ longer than at preſent, inſtead of 2′..50″, which is the reſult of Bailly's ſuppoſition. During the intervening period of 2400 years, the variation was between theſe two quantities, if we cannot reduce the error of the tables to leſs than 1′..5″. The ſmallneſs of this error is favourable to the antiquity and accuracy of the Indian aſtronomy.

The greateſt equation of the ſun's centre is in the tables 2°..10′..32″. At preſent, according to De la Caille, it is 1°..55′½ or 15′ leſs than with the Brahmins. De la Grange has ſhewn, that this equation is ſubject to alternate diminution and increaſe, and has been diminiſhing for ages. In the year 3102 before our era it was 2°..6′..28″½, or only 4′ leſs than by the tables. By the ſame formula 4300 years before Chriſt, it was 2°..8′..16″, and by giving this antiquity to the Indian aſtronomy, the error in the equation is only 2′.

The Brahmins make the obliquity of the ecliptic 24°. By adding according to De la Grange's formula 22′..32′ for the variation, to the obliquity in 1700, that is, to 23°..28′..41″, we have 23°..51′..13″ for the obliquity in the year 3102 before Chriſt. 1200 years before this period it was 23°..57′..45″, ſo that the error of the tables on the latter ſuppoſition does not much exceed 2′.

Hence from the coincidence of theſe three quantities, the length of the tropical year, the equation of the ſun's centre, and the obliquity of the ecliptic, we may reaſonably refer the antiquity of the Indian aſtronomy to the year 3102 before Chriſt, or to a period ſtill more ancient.

In the tables of Chriſnabouram, the mean motions of the planets are given with conſiderable accuracy, and in each are diſtinguiſhed two inequalities called the ſchigram and the manda. The firſt is the ſame with what we call the parallax of the earth's orbit, and its magnitude is aſſigned by a law, which approaches very nearly the truth. The other inequality coincides with that of the planet's centre, is given very near the truth for all except Mercury, and varies as the ſine of the planet's diſtance from its aphelion.

To correct the mean place of a planet, their rules are ſingular. For a ſuperior planet, they do not uſe the mean anomaly, as the argument for finding out the equation manda, but of that anomaly corrected firſt by half the equation ſchigram, and afterwards by half the equation manda. By the equation of the centre, obtained with this argument, the mean longitude is corrected, and its true heliocentric place found, and by applying the parallax of the annual orbit, the geocentric place is obtained.

For the inferior planets, the equation manda, or of the centre is applied to correct not the mean place of the planet, but that of the ſun, to which is applied the equation ſchigram, involving the planet's elongation from the ſun, and thus giving the geocentric place. Hence the centre, about which the inferior planets revolve, has the ſame apparent mean motion with the ſun, but its other properties are not determined.

Theſe tables have a reference to the great epoch of the Calyougham, at which time all the planets were in conjunction with the ſun in the beginning of their moveable zodiac. According to our tables there was ſuch a conjunction of all except Venus, but they were not ſo near as repreſented in the Indian aſtronomy, which in this inſtance was probably perverted by ſome ſuperſtitious notions, relating to the beginning of the Caliougham.

The aphelion of Jupiter ſuppoſed in the tables to have a retrograte motion of 15° in 200000 years, was at the epoch of 1491 in 5*s*..21°..40′..20″ from the beginning of the zodiac; therefore in the year 3102 before Chriſt, it was in 3*s*..27° from the equinox. By De la Lande's tables, it is only 3*s*..16°..48′..58″. From one of De la Grange's formulas it is 3*s*..26°..50′..40″. So ſmall a difference is eaſily to be accounted for in calculations 5000 years diſtant from one another.

According to De la Lande, the equation of Saturn's centre is at preſent 6°..23′..19, and by applying one of the formulas above-mentioned, 3102 years before Chriſt, it was 7°..41′..22′. The Brahmins make it 7°..39′..44′, leſs than the preceding equation by only 1′..38′.

The equations of the other planets are not given with equal accuracy, but it is to be obſerved that the two great geometers, who ſhare between them the glory of perfecting the theory of diſturbing forces, have each contributed to eſtabliſh the antiquity of the Indian aſtronomy.

De la Place has diſcovered, that from the mutual action of Jupiter and Saturn on each other, there are periodical inequalities in them, one not leſs than 877 years, ſo that the mean motion muſt be different, if determined by obſervations made in different parts of thoſe periods. "Now I find, ſays he, by my theory, that at the "Indian epoch of 3102 years before Chriſt, the apparent and annual mean motion "of Saturn was 12°..13′..14″, and the Indian tables make it 12°..13′..13″. In like "manner I find, that the annual and apparent mean motion of Jupiter at that epoch "was 30°..20′..42″, preciſely as in the Indian aſtronomy."

Thus from the agreement of nine aſtronomical elements, with the diſcoveries made in the theory of gravity in modern times, and with which the Brahmins do not appear to have been at all acquainted, we may infer that the obſervations muſt have been made 3000 years before the Chriſtian era. But leſt it ſhould be ſuppoſed that they might have ſome relation to the Greek aſtronomy, let us examine the geometrical principles employed in the conſtruction of the tables.

To find the time of the ſun's continuance above the horizon on the day of an eclipſe, they obſerve the ſhadow of a gnomon on the day of the equinox, whoſe height as well as the length of the ſhadow is divided into 720 equal parts. At the end of the firſt month after the equinox, the day exceeds twelve hours by one third of this number in minutes, it increaſes four-fifths during the ſecond month, and one-third during the third month. Here it is ſuppoſed, that the ſame ratio every where exiſts between the arch, meaſuring the increaſe of day at any place, and the tangent of the latitude, which may hold in places of low latitude, but in others would lead to errors too conſiderable to eſcape obſervation.* As from the former rules we are enabled to aſcertain the time of their formation, we may from this circumſtance conclude, that the place in which they were made, was certainly Hindoſtan, and that the knowledge of the Brahmins in ſpherical trigonometry was not inconſiderable.

Having thus obtained the variations in the length of the day, or the aſcenſional differences, they apply them to know the point of the ecliptic on the horizon, at the time of an eclipſe. A table of the right aſcenſions in time of the points of the ecliptic is calculated, to which the aſcenſional differences are applied, for the time each ſign takes to deſcend below the horizon of the place. This table is calculated only for the beginning of each ſign, and is only carried to minutes of time, but, as far at it goes, is done with perfect accuracy.

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* Let O = obliquity of the ecliptic x = exceſs of the ſemidiurnal arch on the longeſt day above an arch of 90°; then ſin. x = tan. O × tan. lat. If G = height of gnomon, and S = length of ſhadow on the equinoctial day, $\frac{S}{G} =$ tan. lat. and ſin. $x = \text{tan. O} \times \frac{S}{G}$. ∴ $x = \text{tan. O} \times \frac{S}{G} + \frac{\text{tan O}^3 + S^3}{6G^3} + \text{tan.} \frac{O^5 \times S^5}{24G^5} +$ &c. or in minutes of time reckoned after the Indian manner $x = 572{,}957 \times (\text{tan. O} \times \frac{S}{G} +$ &c.)

If O = 24° tan. O = ,4452, and the firſt term of the formula gives $x = 572{,}957 \times \frac{4452 S}{G} = 255 \frac{S}{G}$ the ſame as with the Brahmins. Their rule reduced into a formula is $2x = 720 \frac{S}{G} \left(\frac{1}{3} + \frac{4}{15} + \frac{1}{9}\right) = 512 \frac{S}{G}$ or $x = 256 \frac{S}{G}$. The error by omitting the reſt of the terms will not at the tropics exceed 1′, and in latitude 45° would amount to 8′.

To find the ſemiduration of a ſolar eclipſe, they ſubtract from the ſquare of the ſum of the ſemidiameters of the ſun and moon, the ſquare of a line drawn perpendicular from the centre of the ſun on the moon's path, and then extract the ſquare root of the remainder for the meaſure of the ſemiduration. Theſe ſteps preſuppoſe an accurate conception of the nature of an eclipſe, and the knowledge which Pythagoras may have derived from India, that the ſquare of the hypothenuſe of a right angled triangle is equal to the ſum of the ſquares of the ſides.

For the ſun's apparent diameter, they take four-ninths of his diurnal motion, and for the moon's one twenty-fifth of her diurnal motion. The diameter of the ſection of the ſhadow of the earth, at the diſtance of the moon, is ſuppoſed five times that of the moon. The apparent diameters of the ſun and moon vary as their angular velocities, a miſtake without the uſe of teleſcopes not eaſily to be obſerved.

In the rule for finding the difference between the true and apparent conjunction at the time of a ſolar eclipſe, is a calculation of the moon's parallax, in which the parallax in right aſcenſion is ſubſtituted for that in longitude, an error which would have been avoided by an acquaintance with the writings of Ptolemy. From this they find the parallax in latitude by ſimilar triangles, making the firſt to the laſt as 25 to 2, or nearly as radius to the tangent of the inclination of the moon's orbit to the plane of the ecliptic. From theſe rules, though ſimple and made ſo long back, there is a near approach to accuracy in their calculation. In two eclipſes of the moon obſerved by Le Gentil, their error did not exceed 23′ of time, and in the duration and magnitude they came ſtill nearer the truth*.

In the tables of Siam, the equations of the centres of the ſun and moon are calculated only for a few points of the orbit, and in thoſe of Chriſnabouram the equation is given for every degree of the mean motion. From the former we cannot tell what deviation there might be from the rule of its varying, as the ſine of the diſtance from the apogee; from the latter it appears to have a ſmall, but regular variation from this law, being greateſt, though then not a minute, when the argument is 30°. The ſun's equation when greateſt, or at 90°, is 2°..10′..32″, therefore at 30°, it ought to be half of this, or 1°..5′..16″. It is however 1°..6′..3″. The above mentioned proportion was therefore not intended to be followed, eſpecially as the difference between the numbers computed by that rule, and thoſe in the tables, decreaſe regularly from the point of 30° both ways, till they vaniſh at the end of the quadrant. The ſame obſervation applies to the tables of Narſapur, and the moon's equations, with this remarkable circumſtance in the latter, that the differences between the numbers calculated by Caſſini's rule, and thoſe in the tables, are not greater than thoſe of the ſun. The equations of the other planets are alſo greater than the ratio

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* The place of the moon's node is called the place of the dragon, literally tranſlated by Le Gentil, la lune offenſée du dragon. It is remarkable, that with us it ſhould be called cauda draconis. Some of their terms are however more rational. The preceſſion of the equinoxes is called ayanangſam from ayanam a courſe, and angſam an atom.

of the ſines of the argument requires, the exceſs being greateſt at 30°, and amounting to ſome minutes for Saturn, Jupiter, and Mars, and in the laſt it is the greateſt.

In ſearching for an hypotheſis to account for this ſeries of ſmall differences, that of a double eccentricity correſponds ſo nearly to the tables, that there is little doubt of their being conſtructed on this principle. The argument in the table bears very nearly the ſame proportion to the correſponding numbers, as the anomaly of the eccentric does to the equation of the centre. Suppoſing a circular orbit, and an uniform angular motion about a point not the centre of that orbit, but as diſtant from it on one ſide as the earth is on the other, the anomaly of the eccentric is the angle, which in ſuch an orbit, the line drawn from the planet to the centre makes with the line drawn from thence to the apogee, with this angle the argument in the Indian tables coincides.* And as this ſuppoſition is applicable to the five planets, making an allowance for the error made in the uſe of the ſchigram or parallax of the annual orbit, the concluſion to be drawn is, that the orbit of each of them in this aſtronomy is a circle, the earth not being in its centre, and that the angular velocity of the planet is uniform about a certain point, as far from that centre on the one ſide, as the earth is on the oppoſite.

From this hypotheſis we are naturally led to remark the affinity between the ſyſtem of the Brahmins, and that of Ptolemy. It may be queſtioned whether this aroſe out of the nature of the ſubject, or in conſequence of ſome communication between the aſtronomers of India and Greece.

The firſt endeavour to explain the phænomena of the heavenly bodies was, by ſuppoſing them to revolve uniformly in circles, of which the earth was the centre. The inſufficiency of this hypotheſis would naturally diſplace the earth from the centre to ſome diſtance from it, and the hypotheſis of the equant would in every country, where aſtronomy and geometry had not advanced beyond a certain point, ſucceed to that of a ſimple eccentric orbit. But that the Indians did not derive it from Greece will appear from ſeveral circumſtances attending this hypotheſis in their tables. Firſt, it is applied by them to all the heavenly bodies, to the ſun and moon as well as the planets. In the Ptolemaick ſyſtem, it extends only to the latter. *2dly.* The uſe made of the anomaly of eccentric as the argument of the equation of the centre is peculiar to the Indian aſtronomy. Ptolemy's tables of that equation for the planets, though proceeding on the ſame hypotheſis, are arranged in a manner entirely different, and have for their argument the mean anomaly. But if the reſemblance between the two ſyſtems were ſtill greater, and muſt be aſcribed to a communication between the authors of them, that communication is more likely to have gone from India to Greece, than in the oppoſite direction.

In the tables of the planets, the equation ſchigram anſwering to the parallax of the earth's orbit, is found by the reſolution of the triangle, whoſe ſides are the diſtances between the earth, ſun and planet, and if we compute it, we ſhall find the angle ſubtended by the earth's diſtance from the ſun, coinciding very nearly with the ſchigram. The argument of this equation is the difference between the mean longitude of the ſun and of the planet. The orbits are ſuppoſed circular, but whether the inequality in queſtion aroſe from the motion of the earth, or of the planet in an epicycle, the centre of which revolves in a circle, is left undetermined. The proportional diſtances of the planets from the earth and ſun, deduced from theſe equations, are not far from the truth.

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* Let x be the equation of the centre, φ the anomaly of the eccentric, e the eccentricity of the orbit, or the tangent of half the greateſt equation, then $x = 2e.\ \text{ſin.}\ \varphi + \frac{2e^3\ \text{ſin.}\ 3\varphi}{3} + \frac{2e^5\ \text{ſin.}\ 5\varphi}{5} + \&c.$

Though we cannot from theſe tables diſcover exactly the proportion of the diameter of a circle to its circumference, according to the Hindoos, yet we find from a paſſage in the Ayeen Akbery, that they approximated very nearly to the truth. They make it to be as 1250 to 3927, differing little from that of Metius, 113 to 355, and being the ſame with one equally remarkable, that of 1 to 3,1416. To diſcover this, the inſcription of a polygon of 768 ſides in a circle, with at leaſt nine extractions of the ſquare root, each as far as ten places of decimals, was neceſſary. This muſt have been done in India, for the Greeks left nothing more accurate than the theorem of Archimedes: and Metius and Vieta flouriſhed only at the time when the inſtitutes of Akbar were collected in India.

On the whole, the following concluſions appear to be eſtabliſhed.

1. The obſervations, on which the aſtronomy of India is founded, were made more than three thouſand years before the Chriſtian era; and in particular, the place of the ſun and moon, at the beginning of the Calyougham, were determined by actual obſervation.

2. Though the aſtronomy, which is now in the hands of the Brahmins, is ſo ancient in its origin, yet it contains many rules and tables that are of later conſtruction.

3. The baſis of the four ſyſtems of aſtronomical tables, which we have examined, is evidently the ſame.

4. The conſtruction of theſe tables implies a great knowledge of geometry, arithmetic, and even of the theoretical part of aſtronomy.

Such concluſions ſeem to follow with the higheſt probability from the facts which have been ſtated. The whole evidence is not as yet before the public, and the reſearches of our countrymen into the repoſitories of Benares, will hereafter confirm or invalidate theſe obſervations.

XIV. *On the Reſolution of indeterminate Problems.* By JOHN LESLIE, *A. M.*

THE object of this paper is to reſolve the complicated expreſſions, obtained in the ſolution of indeterminate problems, into ſimple equations, by help of a ſingle principle, admitting though extremely ſimple of a very extenſive application.

Let $A \times B$ any compound quantity $= C \times D$, and let m be any rational number aſſumed at pleaſure. Then $A \times mB = C \times mD$. Suppoſe $A = mD$, then $mB = C$ or $B = \frac{C}{m}$. Thus we have two equations of a lower dimenſion, and by aſſuming multiples n and p, we have four equations ſtill more ſimple: Thus an higher equation admitting of diviſors will be reſolved into thoſe of the firſt order, the number of which will be one greater than that of the multiples aſſumed, and the number of ſimple equations, into which a compound expreſſion can be reſolved, is equal to the ſum of the exponents of the unknown quantities in the higheſt term. A problem therefore can be ſolved by this principle, only when the aggregate ſum, formed by the addition of the exponents in the higheſt terms of the ſeveral equations propoſed, is at leaſt equal to the number of the unknown quantities, together with that of the aſſumed multiples.

The mode of applying this principle is illuſtrated by ſeveral inſtances.

I. To find two rational numbers, the difference of the ſquares of which ſhall be a given number.

Let the given number $= ab$ then $x^2-y^2 = ab = (x+y)(x-y)$. Let $x+y = ma$ then $x-y = \frac{b}{m}$ by the 1ſt. equation $x = ma - y$ and by 2d. $x = \frac{b+my}{m} \therefore ma - y = \frac{b+my}{m} \therefore \frac{m^2a-b}{2m} = y \therefore x = \frac{m^2a+b}{2m}$.

Suppoſing it required to find a number, which increaſed or diminiſhed by 10, produces ſquares. This number is either $x^2 - 10$ or $y^2 + 10 \therefore x^2 - y^2 = 5 \times 4 \therefore x = \frac{5m^2+4}{2m}$ let $m = 2$ and $x = 6 \therefore$ the number is 26.

II. To find two numbers, the ſum of whoſe ſquares is equal to the ſum of two given ſquares.

$x^2 + y^2 = a^2 + b^2 \therefore x^2 - a^2 = b^2 - y^2 \therefore (x+a)(x-a) = (b+y)(b-y)$ $\therefore x + a = mb - my$ and $x - a = \frac{b+y}{m}$. By the 1ſt. $x = mb - my - a$ by the 2d. $x = \frac{ma+b+y}{m} \therefore mb - my - a = \frac{ma+b+y}{m} \therefore y = \frac{m^2b-2ma-b}{m^2+1} \therefore x = \frac{m^2a+2mb-a}{m^2+1}$.

If $a = 5$, $6 = 10$, and $m = 2$ $y = \frac{40-20-10}{5} = 2$ and $x = \frac{20+40-5}{5} = 11$

$2^2 + 11^2 = 125 = 10^2 + 5^2$.

III. To find two rational numbers, whoſe ſquares, together with any given multiple of their product, are equal to a given ſquare.

$x^2 + y^2 + bxy = a^2 \therefore x^2 + bxy = a^2 - y^2 \therefore x(x+by) = (a+y)(a-y)$ let $x + by = ma - my \therefore x = \frac{a+y}{m} \therefore x = ma - my - by = \frac{a+y}{m} \therefore y = \frac{m^2-1}{m^2+mb+1} \times a \therefore x = \frac{2m+b}{m^2+mb+1} + a$.

IV. To find two numbers, ſuch that each, increaſed by unit, ſhall be a ſquare, and their ſum increaſed by unit a given ſquare.

Let the numbers be $x^2 - 1$, and $y^2 - 1 \therefore x^2 - 1 + y^2 - 1 + 1 = x^2 + y^2 - 1 = a2 \therefore x2 - 1 = a^2 - y^2 \therefore (x+1)(x-1) = (a+y)(a-y) \therefore x + 1 = ma - my$, and $x - 1 = \frac{a+y}{m} \therefore x = ma - my - 1 = \frac{a+y+m}{m} \therefore y = \frac{m^2a-2m-a}{m^2+1} \therefore x = \frac{m^2+2ma-1}{m2+1}$.

Let $a = 8$, $m = 2$ ∴ $x = \frac{4+32-1}{5} = 7$, and $y = \frac{32-4-8}{5} = 4$ ∴ the numbers are 48 and 15, and $48 + 15 + 1 = 64 = 8^2$.

Theſe inſtances ſufficiently explain the mode purſued by the writer, which is continued in ſeveral problems.

V. To find two ſquares which diminiſhed by unit ſhall be in a given ratio.

VI. To find a number, ſuch that if given multiples of it be increaſed by given numbers, the product of the ſums ſhall be a ſquare.

VII. To find rational values of x and y, in the general quadratic $Aa^2 + xB + C = y^2$.

Of this there are given four caſes.

1. When the firſt term is a ſquare.

Let $A = a^2$ the equation becomes $a^2 x^2 + Bx + C = y^2$ ∴ $bx + c = y^2 - a^2 x^2$ ∴ $b\left(x + \frac{c}{b}\right) = (y + ax)(y - ax)$.

2. When the third term is a ſquare.

Let the equation be $a^2 + Bx + c^2 = y^2$ then $ax^2 + bx = y^2 - c^2$ ∴ $(ax + b)x = (y + c)(y - c)$.

3. When $B^2 - 4AC$ is a ſquare.

Let $x^2 + \frac{b}{a}x + \frac{c}{a} = D \times E$, then the diviſors of $ax^2 + bx + c$ are $\frac{a}{n}D$ and nE.

But the exceſſes of x above the roots of the quadratic $x^2 + \frac{b}{a}x + \frac{c}{a} = 0$ are the diviſors of the expreſſion $x^2 + \frac{b}{a}x + \frac{c}{a}$ ∴ $D = x + \frac{b + \sqrt{b^2 - 4ac}}{2a}$, and $E = x + \frac{b - \sqrt{b^2 - 4ac}}{2a}$. When $\sqrt{b^2 - 4ac}$ is a whole or fractional number the expreſſion $ax^2 + bx + c$ admits of reſolution and the diviſors are $\frac{a}{n}\left(x + \frac{b + \sqrt{b^2 - 4ac}}{2a}\right)$ and $n(x + \frac{b + \sqrt{b^2 - 4ac}}{2a}$, theſe being found the ſolution will be obtained by problem VI.

4. When the general quadratic can be reſolved into factors, if diminiſhed by a given ſquare.

Let $(ex + f)(gx + h) = y^2 - d^2$ then $(ex + f)(gx + h) = (y + d)(y - d)$.

VIII. Let c and d be known values in the expreſſion $ax^2 + b = y^2$, and from theſe let it be required to diſcover others.

$ax^2 + b = y^2$, and $ac^2 + b = d^2$ ∴ $ax^2 - ac^2 = y^2 - d^2$ ∴ $(ax - ac)(x + c) = (y + a)(y - d)$.

IX. To find two rational numbers, the ſum of which ſhall be equal to a given number, and the ſum of their ſquares a ſquare.

X. To find two numbers, whoſe ſum ſhall be a given number, and the product of the ſums formed by adding given numbers to them a ſquare.

XI. To find two numbers, ſuch that if to each their ſum and difference unit be added, the numbers reſulting ſhall be ſquares.

XII. To find three numbers, the product of any two of which increaſed by unit, ſhall be a ſquare.

XIII. To find a cube, which ſhall be equal to the product of a ſquare by a given number.

XIV. To find two numbers, the ſum of which ſhall be a given ſquare, and the ſum of their cubes a ſquare.

XV. *A Diſſertation on the Climate of Ruſſia.* By Matthew Guthrie, *M. D. Phyſician to the Imperial Corps of Noble Cadets at Peterſburg, F. R. S. S. Lond. and Edin. With two Letters from his Excellency M. Æpinus, Counſ. of State, Knt. of the Order of St. Anne, &c. &c.*

DR. Guthrie had, in the ſecond volume of the Medical Commentaries, mentioned a deſign of tracing the effects of a cold climate upon the human body, and had publiſhed in the ſixty-eighth volume of the London Philoſophical Tranſactions, a *Diſſertation on the Antiſeptic Regimen of the Natives of Ruſſia*, which may be conſidered as in ſome meaſure a part of this plan. In the preſent paper he proceeds directly to the execution of his deſign, beginning with the Hiſtory of a Northern Climate; which is to be followed, in another paper, by that of its Phyſical Influence.

In drawing up this Hiſtory, he has made uſe of the Meteorological Regiſter kept in the Imperial Academy of Sciences; he has adopted the Academy's diviſion of the year into two ſeaſons only, ſummer and winter; he has prefixed to each ſeaſon an enumeration of the common phænomena of froſt, ſnow, rain, &c. he has founded his calculations on a mean of fifteen years, and he has added to the regiſter the comparative degrees of Fahrenheit's and Reaumur's thermometers, anſwering to the ſcale of De Liſle.

He commences with an account of the *Ruſſian Winter* with the common phænomena attending it. This ſeaſon generally laſts from the end of September to the beginning of May, though occaſionally with the interruption of ſome pleaſant weather in April. The mean period of the duration of froſt and ſnow is from October 9, to the beginning of May, or about 230 days. The term, however, of the rivers remaining frozen, by which the real Ruſſian winter is characteriſed, is only from November 27 to April 19, or 160 Days.

The thickneſs of the ice in the Neva in February is about three quarters of a yard; but what is ſingular, it has not loſt above a third of this, when it has become ſo weak, at the breaking up of the ice, as not to bear a dog. This the writer imputes to its having loſt its *cementing principle*; for he has remarked its ſtructure to be that of a maſs of long ſolid cryſtals diſpoſed perpendicularly, reſembling the pipes of an organ; ſo that when on the ſurface it ſeems reduced to a pellicle, it ſtill retains that conſiderable thickneſs in looſe coheſion under the water.

From the regiſter of the thermometer, it appears that the greateſt cold exceeds 24 below 0 of Fahr. and that the medium for the ſix winter months is 27 above 0 in the afternoon, 23 at night. The medium of the barometer is 28.02 Paris inches.

The prevailing winds are weſt and ſouth.

The mean quantity of melted ſnow and rain does not exceed about five Paris inches. Hail and tempeſts are both rare. The Aurora Borealis appears 16 or 17 times in the ſix months. Parheliums and Mock Moons are pretty frequent.

During the ſevere froſt, the air is extremely electric, as appears from the great power of electrical machines, and other circumſtances. The writer, however, does not aſſert that the total of electric fluid in the atmoſphere, is greater in winter than in ſummer; but that, from the abſence of clouds, it is more equally diffuſed through the air, and more readily drawn from it.

He obſerves that much leſs is ſuffered from the cold in Ruſſia, by perſons in eaſy circumſtances, than might be imagined from the ſeverity of the froſt; the fur dreſſes, ſtoves, and double windows, ſufficiently preſerving the body againſt its influence. This accounts for the fact, that natives of Peterſburg, and foreigners who have long reſided there, complain of cold during the winters of much more temperate climates.

The ſeaſon of ſpring ſcarcely exiſts in Ruſſia; the melting of the ice and ſnow being almoſt immediately ſucceeded by ſummer heat.

The *Ruſſian Summer* is exactly the oppoſite extreme to the winter, being nearly as hot, as that is cold. One reaſon for this great degree of heat is the almoſt perpetual preſence of the ſun during the middle of ſummer, which does not give time for the cooling of the earth and air; hence the heat is more oppreſſive than in ſome of the hotteſt climates in the ſouthern regions. The greateſt height of the thermometer is about 85 of Fahr. the mean heat of afternoon, 59; of night, 49. The mean height of the barometer, 28.04 Paris. The weſt winds are predominant in this ſeaſon likewiſe. The quantity of rain falling in the ſix months is about 11 Paris inches. On trying the heat of the water in a well about four yards from the ſurface, on May 9, when there was ſtill ſome floating ice in the river, it very nearly coincided with the mean heat of the climate throughout the year. The ſtate of the atmoſphere during the ſummer ſeaſon is in generally pretty fixed, with ſerene air both day and night, and heavy dews from the ſetting to the riſing of the ſun. The ſultry weather is obſerved to have a much greater debilitating effect upon foreigners than natives, which is attributed to the conſtant uſe made by the latter of the vapour bath, extremely heated, and to their cloſe and ſtoved manner of living during winter, accuſtoming them to endure high degrees of heat.

The *two letters on Electrical and other Phenomena*, by *M. Æpinus*, are addreſſed to Dr. Guthrie. The firſt begins with an account of ſome remarkable electric appearances during a very ſtrong froſt, exhibited by Prince Orloff, and the Grand Duke. Sparks were plentifully produced from the hair of the former, when combing, and his whole body became ſtrongly electric. His Highneſs, the Duke, throwing himſelf on a bed, covered with a damaſk quilt laced with gold, on rubbing it with his hands in all directions, appeared to ſwim in fire, flames riſing round him, darting to the gold lace, and running along it to the top of the bed. Prince Orloff likewiſe was able to electrify himſelf by merely whirling a ſable muff a few times round his head. Similar experiments were made in various houſes in Peterſburg during the hard froſt. M. Æpinus makes the following obſervations on theſe facts. In the firſt place, nothing indicates that the air contains more electric matter at theſe than at other times; but only that other bodies by friction are rendered more readily and ſtrongly electric. All to be accounted for, therefore, is, why bodies in this ſtate of atmoſphere become in a more eminent degree than uſual, ideo-electric. Now, air is a menſtruum, and in its ſolution of water, follows the uſual law of ſolvents, viz. it holds much more in ſolution when hot than when cold. In a great froſt, therefore, the air is in the dryeſt poſſible ſtate. Such air, then, admitted into a hot chamber, will attack the humidity of all the matters it meets with there, and render them uncommonly dry. Air, ſilk, wool, hair, wood, are imperfect ideo-electrics, and alſo attract moiſture. But water is, after metals, the moſt perfect conductor of the electric fluid, and therefore the leaſt of an ideo-electric. The bodies above-enumerated, therefore, being deprived of their moiſture during the ſevere froſt, become much better ideo-electrics than common; and hence have a diſpoſition to become eaſily and ſtrongly electric.

A few remarks follow, relative to M. Æpinus's ſuppoſition of the univerſal repulſive force of bodies, maintained in his *Tentamen Theor. Electric. & Magnet.* They are to ſhow, that the theory of the exiſtence of two diſtinct electric fluids, one poſitive, the other negative, is not different from his.

The ſecond letter contains an idea to account for that undeſcribable ſenſation, conſiſting of a ſort of laſſitude or torpor of body and mind, joined with reſtleſſneſs, which is always experienced after ſevere cold has continued ſome time. This conjecture is, that the drying quality of the cold air robs the human body, as well as other bodies, of its perſpirable fluids, and perhaps of the vital ſpirits along with them. As a remedy, he propoſes hanging up a wet cloth in the chamber.

PAPERS OF THE LITERARY CLASS.

I. *An Account of ſome extraordinary Structures on the Tops of Hills in the Highlands; with Remarks on the Progreſs of the Arts among the ancient Inhabitants of Scotland.* By ALEXANDER FRASER TYTLER, *Eſq. F. R. S. Edin.*

IN a pamphlet publiſhed in the year 1777, by Mr. John Williams, mineral-engineer, and, likewiſe, in a paper tranſmitted in the ſame year to the ſociety of Antiquaries of London, by Dr. James Anderſon of Monkſhill, an account is given of certain vitrified materials, on the ſummits of ſeveral hills in the Highlands of Scotland. Theſe gentlemen agree in thinking that the materials in queſtion, are the remains of fortifications, and that their vitrification was produced by fire, employed by the builders for the purpoſe of cementing their component parts.---On the other hand, the Biſhop of Derry and Thomas Weſt, Eſq. conſidered them as the veſtiges of an ancient volcano, and ſeveral members of the Royal Society of London, having examined ſpecimens of the burnt matter, judged them to be real lava; while the late Andrew Croſbie, Eſq. member of the Royal Society of Edinburgh, ſuppoſed this lava, and the whole of one of the hills, to have been thrown up from the bottom of the ſea by the operation of inteſtine fire.

The writer of this paper, whoſe curioſity was excited by theſe different opinions, has examined ſeveral of the hills alluded to, and now communicates the reſult of that examination; which, however, relates principally to Craig-Phadrick, near Inverneſs.

Craig-Phadrick, ſituate about a mile to the north of Inverneſs, is acceſſible on the weſt by a narrow level ridge, which joins it to the chain of hills upon Loch-Neſs; and on the ſouth-eaſt, by an eaſy aſcent from the high grounds above the town of Inverneſs. On approaching it from the level ridge, a deep and narrow road, cut through the rock from the bottom to the ſummit, firſt preſents itſelf to view. Towards the middle of this aſcent, a ſmall platform appears overhanging the road, on the edge of which are placed four enormous ſtones, evidently intended to block up the road on an alarm of danger. Near the ſummit of the hill there is an outward wall ſurrounding it, the remains of which are ſtrongly vitrified, except, for about ſeventy yards on the north ſide, where the rock is almoſt perpendicular, and the rampart is formed of only dry ſtones and earth. On the ſide towards Inverneſs, where the hill is more acceſſible, there is a prodigious mound of vitrified matter, more than forty feet thick; and, adjoining to it, is an out-work, conſiſting of two ſemi-circular vitrified walls, with a narrow paſs in the middle, which appears to have been the principal entry to the fort, and might have been eaſily defended, or, on the ſhorteſt notice, blocked up with ſtones and earth. Ten or twelve feet within this outward wall, there is another wall of conſiderable thickneſs and height, incloſing a level ſpace about ſeventy-five yards long, and thirty broad. It appears to have been armed with four baſtions, and contains evident traces of artificial operation.

With regard to the nature of the ſtone of Craig-Phadrick, it ſeems that moſt of the neighbouring hills are compoſed wholly, or in part, of the ſame materials, but do not exhibit any appearance of the effects of fire. The ſtone itſelf is a mixed maſs of differently coloured granite, greyiſh or ſpeckled quartz, and the common white quartz. Unlike the volcanic tufas, it contains neither pumice nor burnt matter, but undergoes a total change, and ſuffers an imperfect vitrification, when expoſed to fire. Of baſaltes likewiſe, found upon all volcanic hills, there is no appearance.

With reſpect to the vitrified matter forming the outward wall, and which no where appears to have been in compleat fuſion, our author, who examined ſome other fortified hills mentioned by Mr. Williams, obſerves, that thoſe which ſhow marks of vitrification ſeem inconſiderable in number, when compared with thoſe that have not been at all affected by fire; and infers from this circumſtance, that the partial appearances of vitrification are not proofs of an ancient mode of building, in which fire was employed as a cement, but its *accidental* effects on ſtructures compoſed of combuſtible and fuſible materials.

On Craig-Phadrick and other hills, where the ſtone cannot be quarried in ſquare blocks, but breaks into irregular and generally ſmall fragments, it would be very difficult to form, with ſuch materials alone, a regular ſtructure poſſeſſing ſufficient ſtrength, and it is conjectured that the mode of raiſing a rampart in ſuch a ſituation, was by driving a double row of ſtakes, warped acroſs by boughs of trees laid ſo cloſely together as to confine the materials, ſuch as wood, earth and ſtones, of all kinds and ſizes, which might be collected and thrown between them. Againſt a building of this nature, fire would be the moſt formidable engine of attack; and, if employed at a time when there happened to be wind to increaſe the heat, the ſtony parts would neceſſarily come into fuſion, and produce a maſs of vitrified matter, marking the ſituation of the ancient rampart.---The ſteepneſs of the rock on the north ſide of

Craig-Phadrick, would render a ſtrong fortification there unneceſſary; and a low fence of ſtones and turf would be ſufficient to prevent the cattle, probably confined between the two walls, from falling down the precipice.

Reſpecting the date of theſe fortifications, it is evident (as the country abounded in lime-ſtone,) that, when they were reared, the uſe of mortar was unknown: and that, as the Romans employed mortar in all their buildings, and taught the Britons the uſe of it, they muſt have been erected prior to the Roman eſtabliſhments in the northern parts of the iſland; that is, at leaſt ſixteen centuries and a half ago. How much earlier than this, is uncertain; but the civilization introduced by the Druids, and a Druidical circle of large ſtones upon Dun-Jardel, (one of thoſe fortified hills which are connected with Craig-Phadrick,) ſeem to authoriſe the conjecture that the date of its fortifications, and, conſequently, of all the reſt of the ſame kind, is prior to the introduction of the Druidical ſyſtem, or the viſitation of this Iſland by the Celtæ of Gaul; for there appears no probability that theſe hill-fortifications were neceſſary under ſuch government as that ariſing from the influence of the Druids, and, if they had been erected after the abolition of Druidiſm, the builders would have made uſe of the ſtones of this circle, which were well ſuited to the purpoſe, inſtead of being at the immenſe pains of procuring materials from the bottom of the hill.---If this conjecture be well founded, it carries the date of theſe ſtructures to a period of antiquity far beyond the records of hiſtory.

II. *Remarks on ſome Paſſages of the Sixth Book of the Eneid.* By James Beattie, *L. L. D. F. R. S. Edin.*

DR. Beattie's chief object in this eſſay is to illuſtrate the moral and theological ſentiments contained in that part of the Eneid, which deſcribes the deſcent of Eneas into the world of ſpirits. With theſe illuſtrations ſome critical remarks are joined, and the eſſay concludes with a few obſervations on the *gates of horn and ivory*, which, it is maintained, are not in this inſtance to be conſidered as allegorical.

III. *An Eſſay on Rythmical Meaſures.* By Walter Young, *M. A. F. R. S. Edin.*

AMONG the internal ſenſes which are the ſource of pleaſure, the perception of order and proportion has a principal place. With reſpect to the objects of hearing, in particular, theſe qualities are eſſential to the production of pleaſure. In an agreeable ſucceſſion of ſounds, order and proportion take place in two different ways. Upon one depends *tone*, or the relation which ſounds bear to each other with regard to acuteneſs and gravity; upon the other, their *rythm*, *cadence*, or *meaſure*. This laſt is the moſt important, ſince tones without meaſure can give no pleaſure to the ear; whereas an artfully diſpoſed ſucceſſion of the ſame tones, as in the beating of a drum, is capable of a conſiderable effect. Tone is the province of the muſician alone: Rythm equally of the muſician and poet, and in ſome degree of the proſe writer. It may be diſtinguiſhed into muſical, poetical, and proſaic. To inveſtigate the leading principles of the two former kinds of rythm is the purport of the preſent Eſſay.

The rythm of muſic requires a variety of proportions in the duration of ſounds; but to produce an uniformity amidſt this variety, they muſt be regulated by ſome ſtandard, which muſt be a determined portion of time, of which every ſound muſt be an aliquot part, or multiple. The intervals of time are equal or unequal. We can by habit eaſily acquire an idea of equal intervals, and we can divide a ſingle interval into a number of equal parts. The eaſieſt diviſion of intervals is into two, four, and ſo on to ſixteen, if our powers of quick motion will permit. The diviſion into three is alſo readily attainable by practice, and by its means, all the compounds of binal and trinal diviſion. Thoſe into five and ſeven are difficult, and we are naturally diſpoſed to halve them into the even and odd numbers of which they are compoſed.

We have the power not only of dividing units of time in this manner, but of forming aggregates of them, by telling off equal parcels of them when rendered ſenſible to the ear. We do this by attending particularly to the firſt ſtroke of each of the parcels: a conſequence of which is, that it appears to us louder or ſtronger than the ſubſequent ones of the ſame parcel, though in fact of the very ſame ſtrength. The laſt of the parcel for the ſame reaſon ſtrikes us as the moſt feeble, giving the impreſſion of a kind of break or pauſe betwixt the parcels. When we count off the parcels by twos and fours, it makes what muſicians call common time; when by threes and ſixes, triple time. We alſo poſſeſs the further power of combining certain numbers of theſe parcels, and conſidering them as ſomething diſtinct from what went before, and is to follow. The parcels by which we firſt count off the intervals are called bars; and combinations of theſe bars form muſical phraſes or ſtrains. The firſt note of every bar is accented, and therefore in hearing muſic draws the attention ſo as to enable us to diſcover how many intervals are contained in each of the equal parcels. Thus a ſtandard or ſcale is conſtructed in our minds, by which we gain an idea of the meaſure.

By a ſingle interval or unit of time is underſtood, not a certain invariable portion of abſolute duration, but a relative magnitude. The ſame portion of time may be conſidered, on different occaſions, as an unit, a multiple, or part. Yet, there are certain notes in the performance of muſic, that are always conſidered as ſingle duration, of which all the longer ones are aggregates, and the ſhorter, parts. Theſe notes, indeed, in different movements, differ in their abſolute duration; but this difference is within certain limits. The longeſt ſound which can be conſidered as undivided is perhaps hardly equal to two ſeconds, nor the ſhorteſt much leſs than half a ſecond. That rythmical proportion is in fact carried on by means of the two oppoſite operations of diviſion and combination, and not by proceeding uniformly from one extreme, is proved by experience; the time of a ſemibreve being marked by four uniform motions of the hand, and conſidered not as one, but as four, times; and the minute ſounds being not conceived individually, but in groups, and referred to ſome longer duration of which they are aliquot parts. The ancients, indeed, accounted their ſmalleſt time as the unit; but it was not leſs than that of a ſhort ſyllable in pronunciation, and they had no ſounds in their ſucceſſions which bore a greater proportion to it than as two to one.

With reſpect to the rythm of poetry, it is to be obſerved, that ſyllables differing in length according to certain proportions, the words of which they are compoſed are capable of rythmical arrangement. A common method of effecting this, is to form the words into parcels according to certain meaſures, and write them out in ſeparate lines in order that they may be perceived. Poetical rythm is neceſſarily much leſs various and complicated than muſical, but it is founded to a certain extent on the ſame principles, having its intervals or units of time regularly divided and combined, its accented and feeble ſounds, and its reſts and pauſes. In the Greek and Latin languages, the proportion between long and ſhort ſyllables being better aſcertained than in the modern, the rythm is more perfect and diverſified. The verſes are parcelled out into feet, each of which marks out a ſingle interval of time, but not always of equal length. Their duration is in proportion to the number of ſmalleſt times, or ſhort ſyllables, contained in each. The units of time of which verſes are compoſed are ſometimes divided into twos and fours, ſometimes into threes. The hexameter verſe is an inſtance of the former, being compoſed of equal units divided into ſix parcels. When the parcels of any rythmical ſucceſſion exceed three in number, we are always diſpoſed to break them down into the ſmaller members of which they are compoſed, which is the origin of the pauſe or cæſural ſtop in verſes. In this diviſion of verſes, we reſt with moſt ſatisfaction upon a long ſyllable, and begin the next member with a ſhort and feeble one, which we ſlide over, as introductory to the meaſure. In the Engliſh language, the accent rather than the real quantity decides the arrangement of poetical meaſures, accented ſyllables having the force of long ones.

In the ſecond part of this Eſſay the writer begins with explaining that ſtructure of meaſured ſounds which may be ſaid to give a regular and perfect rythm. For this purpoſe it is neceſſary that all the units be equal intervals of time, and that their diviſions be ſimple and obvious. It is further neceſſary that the whole ſucceſſion be made up of parcels of ſome determined number of units, and be ſo contrived that the hearer be led without heſitation to adopt that number, and retain it to the end of the ſucceſſion. This is done by various contrivances; as the alternation of a parcel of undivided, and a parcel of divided, units; the interpoſition of reſts or pauſes; the return of ſimilar ſounds; &c. The pleaſure is alſo enhanced if we are led to join three or four of theſe parcels together, thus forming larger combinations; and the rythm is ſtill more perfect, when the entire piece conſiſts of ſome ſimple and agreeable number of ſuch aggregates. This is the conſtruction of thoſe pieces of muſic which are called *airs*.

From this perfect and regular ſtructure artiſts have gradually deviated in order to produce variety. They firſt probably diverſified the uniform movement by pairs and double pairs, by throwing in an additional pair, and thus making combinations of three or ſix pairs. Thence they readily came to arranging by parcels of three units, and thus the ſimple triple time was obtained. The diviſion of the unit into three parts was an eaſy tranſition from this; as alſo the combination of ſtrains into threes. In all theſe caſes, however, the bars or firſt parcels being equal, the rythm would be regular. The leaſt offenſive deviation from this regularity is the departing occaſionally from the uniform equality of the ſtrains or larger combinations. This is done in various ways, inſtances of which are found among the muſical compoſers; and all may be uſed with good effect. But changes in the bars themſelves, or ſingle parcels, are always ſenſibly felt, and when improperly introduced never fail to diſpleaſe. They may be made either by increaſing or diminiſhing the unit, and thus making the movement quicker or ſlower. In a long piece of muſic ſuch changes ſkilfully managed tend to enliven and ſurpriſe.

The preceding obſervations relate to muſic; but to a certain extent they are applicable to the rythm of poetry. If the time of a ſhort ſyllable be conſidered as the unit of verſe, the feet will be analogous to the bars, and the verſe, to the ſtrains, of muſic, and the ſtanza will repreſent the entire piece. The meaſure of a verſe is intimated to the reader by writing them in ſeparate lines; but for a hearer ſome other contrivance is neceſſary. The name of *verſe* implies *return.* This is produced by the return of ſimilar arrangements of long and ſhort ſyllables, the return of ſimilar ſounds, and by pauſes. The ſimilarity of ſucceſſion in long and ſhort ſyllables may take place either through the whole line, or a part of it. The firſt mode being defective in variety, the ſecond has been more generally practiſed by the ancients, as in the hexameter, where the ſimilarity occurs at the end of the line. But where all the feet are nearly the ſame, an impreſſion of the meaſure is given by the tone of voice with which the lines are read. The Engliſh verſe of ten ſyllables muſt depend upon a kind of pauſe at the end of the line for its meaſure; and hence an objection againſt blank verſe, in reading which the ſenſe will often prevent any perception of the meaſure. Rhyme, or a returning ſound at the end of a verſe, ſerves to mark out the meaſure more plainly. Verſes may be formed ſo as to give the impreſſion, not only of equal parcels and combinations, but of diſtinct aggregates of thoſe combinations, which is effected by a return of like cadences, by pauſes, and by rhyme. In theſe caſes they follow the model of perfect and regular rythm. They may deviate from it in the unequal length of the lines; but ſtill if they are all compoſed of equal-timed feet, the rythm is in ſome degree regular. But the ancients have ſometimes deviated ſo far as to compoſe the different lines of a ſtanza of different-timed feet, as the hexameter and iambic; nay even to admit different-timed feet into the ſame line; but we are ſo ignorant of their manner of pronunciation, that we know not what accommodation they employed to give a diſtinct impreſſion of theſe feet in reciting.

IV. *On certain Analogies obſerved by the Greeks, in the uſe of their Letters, and particularly of the Letter Sigma.* *By* ANDREW DALZEL, *M. A. &c.*

IN an introduction to the obſervations, which are chiefly confined to the letter ſigma, the author remarks, that one of the moſt obvious diſpoſitions between man and other animals is the power of articulating ſounds. Hence the expreſſion in Homer and Heſiod, μεροπες ανθρωποι, men having an articulate voice; μεροψ being evidently compounded of μειρω, to divide, and οψ, the voice.

The analyſis of theſe articulate ſounds, or ſyllables, into their conſtituent parts, or ſimple elements, ςοιχεια or letters, muſt originally have been a work of immenſe ingenuity. And, though no alphabet contains a ſufficient number of letters, to expreſs every articulate ſound, yet they are ſufficient to denote all the requiſite elementary ſounds in their reſpective languages. Letters are called by the Greeks, γραμματα, things written, derived from γραφω, to write: a word, which originally ſignified to carve, and was afterwards applied to writing in general.

It has been wiſhed, that to obviate the inconvenience ariſing from the variety of languages now in uſe, a method of ſpeech, capable of being conveyed by writing, had been invented, which at leaſt every poliſhed nation might have been able to adopt and underſtand. But, as language is a ſort of mutual convention among thoſe, who uſe it, the diviſion of the world into ſo many different nations, renders the introduction of an univerſal language quite impracticable. Hence many have periſhed, and of others we have in a great meaſure loſt the pronunciation, but are ſtill able, after a conſiderable degree of pains, to underſtand the meaning, perceive the beauties, and derive eſſential advantages in improving and poliſhing our own language.

From none do we derive greater advantages, than from that of the ancient Greeks. It is allowed to be, even in its minuteſt parts, of all others the moſt complete and beautiful. To inveſtigate the nature of each letter would lead us into too wide a field, and this eſſay is deſtined more particularly, to enquire into the principal uſes of the letter ſigma.

The Dorians differ from the other Greeks in calling this letter Σαν, as we learn from the firſt book of Herodotus, Δαριεες μεν το σαν καλευσι Ιωνες δε σιγμα. Hence the horſes branded with this letter are called by Ariſtophanes, Σαμφοϱαι. The elemental ſound of this letter is the ſame as denoted by the Engliſh S, in the words ſame, deſignation, diſtreſs. “ The Sigma is pronounced, ſays Dionyſius of Halicarnaſſus, by “ an appulſe of the tongue to the palate, while the breath ruſhes through the middle “ part of it, and emits a gentle and conſtricted ſibilation about the teeth.” The name is derived from σιζω, to hiſs, hence it has been called the ſerpentine letter, and ſome have ſuppoſed, that various ſhapes of a ſerpent have been copied in its different forms. Theſe are, two for the capitals Σ, C, and three for the ſmall letters σ, ϲ, ς, of which the laſt is always final. To comprehend the uſe of the ſigma, a ſhort view of the other conſonants will be neceſſary.

Dr. Wilkins has accurately ſtated the difference between vowels and conſonants in the following words. “ Thoſe letters are called vocales, vowels, in pronouncing “ of which by the inſtruments of ſpeech, the breath is freely emitted, and they are “ therefore ſtyled apert, or open letters. Thoſe letters are ſtyled conſonants, in the “ pronouncing of which the breath is intercepted by ſome colliſion or cloſure “ amongſt the inſtruments of ſpeech, and for this reaſon they are ſtyled clauſæ “ literæ.” The ſeventeen Greek conſonants were divided into eight ſemivowels and nine mutes. “ Of the conſonants, ſays Theodore Gaza, ſome are “ ſemivowels as ζ, ξ, ψ, λ, μ, ν, ϱ, σ, of which ζ, ξ, ψ, are double, and λ, μ, ν, ϱ, are “ immutable and liquid”. Gaza, from the authority of Dionyſius the Thracian, and probably of Apollonius Dyſcolus, and Conſtantine Laſcaris, omit σ in the ſubdiviſion of the ſemivowels into double conſonants and liquids. Emanuel Chryſoloras is more explicit. “ How are the ſemivowels divided? Into three ſorts, double con- “ ſonants, immutable conſonants, and σ. How many are double? Three, ζ, ξ, ψ. “ How many immutable? Four, which are alſo called liquids, λ, μ, ν, ρ.” The remaining conſonants are called mutes, three, π, κ, τ, ψιλα, ſmooth; three, φ, χ, θ, δασεα, rough; and three, β, γ, δ, μεσα, intermediate. The firſt rank, π, β, φ, are labials, the ſecond, κ, γ, χ, palatines, the third, τ, δ, θ, dentals. The difference between a vowel, a ſemivowel, and a mute, is well defined by Ariſtotle. “ A vowel is that, which, “ without an alliſion of the organs, hath an audible ſound, as α and ω. A ſemivowel “ is that which, with an alliſion, hath an audible ſound, as σ and ρ. A mute is that “ which, with an alliſion, hath by itſelf indeed no audible ſound, but is audible in “ conjunction with the vowels, as γ and δ.”

A more natural arrangement of the letters, according to their elemental ſounds, might have been made, and indeed it has been done by Hulewicz, one of the beſt modern writers on Greek grammar. Thus the labials β, μ, π, φ, χ, might have been claſſed together; the dental, ζ, ϱ, σ; the lingual, δ, θ, λ, ν, τ; the palatine, γ, κ, χ, ξ. But to underſtand their uſe, and their changes in the different inflections and tenſes of verbs, we muſt adhere to the diſtribution of the ancient grammarians.

To return to the ſigma. Some, in the arrangement of conſonants, give it no place at all. Some place it aukwardly enough among the double conſonants. Others, allowing it to be a ſemivowel; but perceiving that it is neither liquid, double conſonant, nor mute, have called it litera ſolitaria, et ſuæ poteſtatis, vel ſui juris; the ſolitary, and the abſolute or independent letter. Let us examine on what grounds it is entitled to this exception, by which we ſhall ſee the neceſſity of ſuch a character in the alphabet of this moſt exquiſite of all languages.

Dr. Samuel Clarke, in a note on the word πελασσε, in the beginning of the thirteenth book of the Iliad, has given a probable reaſon for this letter being conſidered as ſuæ poteſtatis. "Πελασσε," ſays he, "muſt certainly be written with a double σ, becauſe "the ſecond ſyllable of πελασε is ſhort. It may, however, be queſtioned, whether the "more ancient Greeks made uſe of that mode of writing. For when they called σ an "arbitrary letter, perhaps they meant, that whereas the letters ζ, ξ, ψ, are neceſſarily dou-"ble, and all the reſt of the conſonants ſingle, σ alone has this peculiarity, that in a great "many places, eſpecially the aoriſts of verbs, it may be pronounced either as a ſimple "or a double letter." This reaſon does not appear to be ſatisfactory, for this privilege of doubling the letter is not peculiar to ſigma. Thus delta is doubled in theſe lines:

"Ως εφατ᾽· εΔΔεισεν δ᾽ ὁ γερων και επειθετο μυθω.
Τον και ὑπεΔΔεισαν μακαρες θεοι ουδε τ᾽εδησαν."

Tau is doubled in ὁ, ττι, inſtead of ὁ, τι; and it is probable that ſuch words were written with a ſingle δ and τ in the times of Homer, as that πελασε was always written with a ſimple σ. Ρ is doubled in εϱϱιπτον, and εϱϱεζε is written with a ſingle and a double ϱ.

Αλλος δ᾽αλλῳ ερεζε θεων αειγενεταων
Οιη δ᾽ουκ ερρεζε Διος κουρη μεγαλοιο.

Λ, though ſingle, muſt be pronounced as double in this line;

Ἡρωων, αυτους δ᾽ ἑλωρια τευχε κυνεσσιν.

On other grounds ſigma may really be called ſolitary or independent.

I. Sigma alone aſſiſts the mutes in making up the double letters. Thus, π, β, φ, with σ, make ψ; κ, γ, χ, with σ, make ξ; and τ, δ, θ, make ζ. Λαιλαψ is the ſame with λαιλαπς, as appears from the genitive λαιλαπος. Αραψ with Αραβς, Αραβος. Κατηλιψ, κατηλιφς, κατηλιφος. Κοραξ, κορακς, κορακος. Φλοξ, φλογς, φλογος. Ονυξ, ονυχς, ονυχος. This is not ſo clearly traced in ζ, and it has been ſaid that ζ is equivalent to σδ, not δς, becauſe ζ is not obſerved to be reſolved into two ſimple conſonants, except in the Doric manner, as μελισδω for μελιζω, and οσδω for οζω. Hulewicz denies that ζ is a double letter, becauſe it does not occur in the termination of words. But the following circumſtances prove that ζ, as well as ξ and ψ, is a final letter. Τ, δ, θ, are allowed by him to be thrown away before σ. Thus from Τυπτω, it is not τυπτσω, but τυπσω or τυψω. Αδω does not make αδσω or αζω, but ασω. Πληθω, not πληθσω or πληζω, but πλησω. Had τς, δς, or θς, remained in the firſt futures of verbs, they would have been confounded with the preſent tenſes of many verbs in ζω. From many genitives in τος, δος, θος, it is certain that many nouns were terminated originally in τς, δς, θς, the ſame as ζ. Thus Λεβητς or λεβηζ, rejecting τ before σ, becomes λεβης, and makes λεβητος. Λαμπαδς or λαμπαζ, λαμπας, λαμπαδος. Ορνιθς, ορνιζ, ορνις, ορνιθος. The formation of the ſecond future of ſuch verbs as οζω prove, that ζ is equivalent to δς. As τυπτω, by throwing out the τ, makes τυπῶ, ſo οζω, οδσω, by throwing out the σ, makes οδῶ. So φραζω, φραδσω, makes φαδῶ, and εζω, εδσω, makes εδω. That ζ is a double conſonant is ſtill more clearly proved, by its obliging a preceding vowel, though naturally ſhort, to become long by poſition, and it is equivalent to τς, δς, θς.

II. Sigma is the only conſonant employed in the formation of the dative plural of the impariſyllabic declenſion. Ρητωρ, ρητορι, ρητορσι. Κοραξ, κορακς, κορακι, κορακσι, κοραξι. Φλοξ, φλογς, φλογι, φλογσι, φλοξι. Βηξ, βηχς, βηχι, βηχσι, βηξι. Ωψ, ωπς, ωπι, ωπσι, ωψι. Αραψ, αραβς, αραβι, αραβσι, αραψι. Δαις, δαιτς, δαιτι, δαιτσι, and by throwing away τ before σ, δαισι. Λαμπας, λαμπαδς, λαμπαδι, λαμπαδσι, by throwing away δ, λαμπασι.

III. The power of ſigma is very conſpicuous in the formation of the Greek verb.

1. It is the characteriſtic of the firſt future in all verbs, that are not liquid. Τιω, τισω; λυω, λυσω; πλεκω, πλεκσω, πλεξω; φευγω, φευγσω, φευξω; βρεχω, βρεχσω, βρεξω.

2. It is ſingular in being never the proper characteriſtic of the preſent; for though there are many verbs ending in ζω, yet as in τυπτω, ριπτω, π is the characteriſtic, ſo in ſuch verbs as φραζω, νομιζω, δ is the characteriſtic. In the Doric dialect φρασδω, νομισδω are uſed. Yet σ is the characteriſtic of the firſt future, and δ is rejected. The verbs ending in σσω plainly belong to a particular dialect, and their futures in ξω come from obſolete preſents; thus πραξω from πραγω, as may be ſeen from the ſecond future πλαγῶ. A few verbs ending in ψω and ξω, as εψω, οδαξω, αλεξω, αυξω, which ſeem to be futures ſubſtituted for obſolete verbs, cannot have any great weight againſt the general rule.

3. Sigma is never the characteriſtic of liquid verbs, the liquid of the preſent always remaining in the future. For the analogy of the Greek language does not permit a liquid to precede σ, except ſometimes in the Doric dialect, ορω, ορσω, or for ſome ſpecial cauſe, as in compound verbs ενσπειρω, to be noticed hereafter.

IV. The independent nature of σ is very ſtriking, when we examine the liquid ν preceding different letters, as the ſolitary ſigma poſſeſſes a ſort of analogy peculiar to itſelf.

1. Εν and συν remain in compoſition before vowels without change, as Εν-αλλασσω, Συν-οικεω.

2. Before the firſt rank of mutes, ν is changed into μ.

$$\text{Εμ}\left\{\begin{array}{l}\text{πιπτω}\\ \text{βαλλω}\\ \text{φορεω}\end{array}\right. \qquad\qquad \text{Συμ}\left\{\begin{array}{l}\text{πειθω}\\ \text{βαινω}\\ \text{φρονεω}\end{array}\right.$$

3. Before the ſecond rank of mutes, ν is changed into γ.

$$\text{Εγ}\left\{\begin{array}{l}\text{κλειω}\\ \text{γραφω}\\ \text{χριω}\end{array}\right. \qquad\qquad \text{Συγ}\left\{\begin{array}{l}\text{καλεω}\\ \text{γελαω}\\ \text{χεω}\end{array}\right.$$

4. Before the third rank of mutes ν remains unchangeable, Εν-τεινω, Συν-ταρασσω.

5. Before a liquid, ν paſſes into a liquid of the ſame kind with that which it precedes.

Ελ-λαμπω	Συλ-λεγω
Εμ-μιγνυμι	Συμ-μαρπτω
Εν-ναιω	Συν-νοεω
Ερ-ριγοω	Συρ-ρεω

In the above caſes, the change was evidently made euphoniæ cauſâ, from the coaleſcing of the ſubſtituted letter better with the ſucceeding, than ν would have done.

6. N before σ, if a vowel follows the σ, becomes another σ, as in Συς-σιτεω. If a mute follows σ, the ν in συν is ſtruck out, in εν it remains.

Συ-

Συ	σπαω	Εν	σπειρω
	σφαλτω		σφραγιζω
	σκαπτω		σκηπτω
	σχηματιζω		σχολαζω
	στρατευω		στρεφω
	ζαω		ζεομαι

N is retained in the caſe of εν, leſt certain perſons of the preſent of the compound verb ſhould be confounded with ſome in the imperfect of the ſimple verb.

V. The peculiar nature of ſigma is ſeen in its being the only hiſſing letter in the alphabet. Z has been conſidered in this light by ſome, but it is no more ſo than ξ and ψ, which derive their hiſſing ſound from σ. Hence the ſigma has been conſidered as a ſervile letter, and many writers have conceived a great diſlike againſt it.

That the ſigma is diſagreeable, when introduced without ſufficient neceſſity, is evident from the cenſure of the critics on a noted paſſage in the Media of Euripides.

Εσωσα σ', ως ισασιν Ἑλληνων όσοι
Ταυτον συνεισε.βησαν Αργωον σκαφος.

Such paſſages might be produced in every language; and our own, from the frequent uſe of s, muſt have been conſidered as harſh and barbarous by thoſe who are offended with a moderate uſe of it in Greek. Dionyſius of Halicarnaſſus, has ſaid, that "the ſigma is harſh and unpleaſant, and, when unneceſſarily repeated, exceedingly offenſive: for its hiſſing ſeems to be connected with what is wild and irrational, rather than with the voice of rational beings. Wherefore ſome ancient authors uſed it but ſeldom and with caution, and others compoſed whole odes without this letter."

This method of judging is certainly faſtidious and hypercritical; a variety of ſuch periods as the following may be found in Herodotus, the ſweeteſt of all proſe writers. Κροκοδειλους δε Ιόνες ωνομασαν, εικαζοντες αυτων τα ειδεα τοισι παρα σφισι γινομενοισι κροκοδειλοισι τοισι εν τησι άιμασιησι. An Ionic ear was not therefore ſo much diſguſted with the ſigma, while both the ſigma and iota might have been intolerable to the Athenians. From their averſion to this letter, the double σσ are changed into the double ττ, θαλαττα for θαλασσα, πραττω for πρασσω, and even συριττω for συρισσω; and to this we are indebted for the humourous eſſay of Lucian under the title of Δικη φωνηεντων, the judgement of the vowels, which has deſcended to our times.

The ludicrous manner of Lucian was undoubtedly the propereſt in treating ſuch a ſubject. Lipſius, in his dialogue de recta pronunciatione latinæ linguæ, enumerates the enemies of the letter s, famam ejus multi petunt, imo vitam. "Pindar reproaches it, and calls it κιβδηλον, ſpurious; and, out of hatred to it, is ſaid to have compoſed verſes without its aſſiſtance. Dionyſius, the rhetorician, in exalting the Ρω, undervalues this letter, and brands it with the vile epithet of θεριωδη, ſavage. All the Attics deteſt it, and generally have ſubſtituted Ταυ in its room. Latin authors ſeem to join in the conſpiracy, and among men of rank, Meſſala ſays, it is not even a letter, but only a hiſs. Among teachers, Quinctilian pronounces it to be a rough letter, and harſh in the combination of words. Nay, even the ancient writers rejected it, in imitation of the Attics; and their method was to uſe mertare and pultare inſtead of merſare and pulſare, juſt as Ennius uſed adgrettus fari, inſtead of aggreſſus fari. The poets alſo have taken a ſide; and, in their verſe, this letter, when a conſonant follows, is commonly expunged. Thus, vitâ illâ dignu' locoque; and, omnibu' princeps; and in the plays of Plautus and Terence, examples frequently occur."

Yet S is not without its defenders. Lipſius, in a dialogue between himſelf and Muretus, vindicates it in the character of the latter, though zeal for his client may, perhaps, carry him too far. "Look down to the earth," ſays he, "among the things "that are ſweet, you find ſeſame and ſugar; among the charms of love, whiſpers "and kiſſes; and among the joys of life, ſleep, ſafety, ſoundneſs."

The ſound of this letter, in fact, is not to be applauded or condemned in the extreme. In ſome paſſages, as in that quoted from Euripides, the frequent recurrence of it is diſagreeable to the ear; but Milton, with manifeſt deſign, makes uſe of its diſcordant ſound, where Satan, inſtead of acclamations, is received by his infernal audience with a general hiſs.

He hears
On all ſides from innumerable tongues
A diſmal univerſal hiſs, the ſound
Of public ſcorn.
He would have ſpoken,
But hiſs for hiſs returned with forked tongue
To forked tongue: for now were all transform'd
Alike, to ſerpents all, as acceſſories
To his bold riot: dreadful was the din
Of hiſſing through the hall.

The ſame poet has, however, in another place produced a pleaſing effect from the judicious introduction of this letter;

——Then with voice
Mild, as when Zephyrus on Flora breathes,
Her hand ſoft touching, whiſper'd thus.

The beginning of the firſt Idyllium of Theocritus is equally melodious.

Ἁδυ τι το ψιθυρισμα και ἁ πιτυς, αιπολε, τηνα
Ἁ ποτι ταις παγαισι μελισδεται· ἁδυ δε και τυ
Συρισδες.

The Doric words μελισδεται and συρισδες, inſtead of μελιζεται and συριζεις, by bringing ſigma before delta, conſiderably augment in this inſtance the ſweetneſs of the ſound.

V. *Account of the German Theatre.* *By* Henry Mackenzie, *Eſq. F. R. S. Edin.*

THIS, being a ſketch of the preſent ſtate of dramatic writing in Germany, taken from a collection of pieces tranſlated into French, and the preface to that collection, does not afford a proper object for our abridgement. German literature is in a way of becoming daily better known by the increaſing ſtudy of the language among foreigners, which alone can afford the proper means of appreciating it.

VI. *Theory of the Moods of Verbs.* *By* James Gregory, *M. D. F. R. S. Edin.*

THE author of this eſſay begins with ſeveral miſcellaneous obſervations, in order to deduce from them certain general principles. Theſe preliminary remarks amount to this: The eſſence of a mood is to denote ſome peculiar energy, or modification of thought. The infinitive is not a mood, becauſe it does not do this, though, beſides expreſſing the general meaning of the verb it comprehends the circumſtances of time, and in ſome languages, of perſons, number and gender. It is however a verb; whence it follows that mood is not eſſential to a verb, but only ſuſceptibility of mood. Care muſt be taken to diſtinguiſh grammatical moods and moods of thought. The former are not the ſame in all languages; and as to the latter, no language has made proviſion for every one of them. Every mood however of either kind may be expreſſed by the infinitive of its verb joined to another verb, in the firſt perſon ſingular or plural of the preſent tenſe of the indicative. A grammatical mood often correſponds to ſeveral moods of thought. Such is the affinity among the moods that they may frequently be interchanged.

From theſe obſervations, illuſtrated and confirmed by oppoſite inſtances, he draws the following concluſions.

I. The energies of thought expreſſed by the moods of verbs may be expreſſed by other verbs and chiefly by acting verbs.

II. Theſe energies are principally the ſocial operations of mind.

III. The grammatical moods are conciſe modes of expreſſing ſome of thoſe combinations of thought which occur moſt frequently, and are moſt important and ſtriking.

IV. The number of grammatical moods is limited by the ſame circumſtances which ſeem to limit the variety, preciſion and perfection of language in other reſpects.

V. Grammatical moods contribute greatly to the beauty of language by the brevity, animation and force which they give to the expreſſion of our moſt familiar and intereſting combinations of thoughts.

VI. Theſe moods, like other inflections of words, expreſs much better than any ſucceſſion of words can do, the intimate connection of ſimultaneous thoughts, which are unnaturally disjoined, and in ſome meaſure altered, when expreſſed ſeparately by a ſeries of words. Dr. Gregory next proceeds to illuſtrate theſe concluſions. Under the firſt, after having obſerved that, though all moods are in ſome degree convertible, yet they are not perfectly ſo, he goes on to ſhew how the indicative, imperative, optative and interrogative are to be converted or reſolved; and he points out the proviſion made in ſeveral languages for expreſſing wonder. Of the ſubjunctive mood he remarks that it expreſſes a great variety of energies and is therefore to be reſolved by a variety of verbs. Under the fourth concluſion he obſerves that no language correſponds to all the varieties and niceties of human thought, and that grammatical moods have been formed to convey to the mind with quickneſs and ſimplicity, ſuch combinations of thoughts only, as could not be expreſſed by circumlocution, without great inconvenience and diſagreeableneſs. In his remarks upon the fifth concluſion, he notices the amazing rapidity of thought, and the quickneſs with which natural language, the language of the countenance, geſture and tone of voice, communicates to others, the emotions of paſſions of our own mind. A grammatical language, he adds, as conciſe as thought, and natural language, is unattainable, but every approximation to it is valuable; and all the moods of verbs are ſuch approximations, by means of which many thoughts are conveyed to the hearer or reader with animation and force, which may indeed be expreſſed in ſome meaſure by the uſe of additional verbs, but not with the ſame advantages. To prove the juſtneſs of his ſixth and laſt concluſion, he reaſons thus: Many of our thoughts are co-exiſtent, and moſt intimately combined, and to this property of thought, the moods of verbs do ſome kind of juſtice. Artificial language preſents neceſſarily ideas in ſucceſſion; and therefore, when our thoughts are in ſucceſſion alſo, is capable of rendering them properly: but the communication of thoughts that offer themſelves to the mind in a maſs, muſt often be greatly injured by the decompoſition they undergo when put into words; and the great excellence of moods, as well as of all inflections, is to counteract this defect of language, as it is their property to expreſs a combination of thoughts by a ſingle word. This remark leads him to the mention of a principle aſſumed by ſome philoſophers, that a perſon can have but one idea at once; and this principle he rejects, as deſtitute of proof, and repugnant to conſciouſneſs.

Mathematical propoſitions, he obſerves, are expreſſions of co-exiſtent thoughts, and a good conſtruction or diagram will ſuggeſt inſtantaneouſly, the whole congeries of thought which conſtitutes both the propoſition, and the demonſtration of a theorem; and this property, this important advantage, moods of verbs and other inflections of words have in common with the diagrams, and formulæ of mathematicians, ſo far as to cauſe combined, and co-exiſtent thoughts to be apprehended by the mind, together in one maſs, at the ſame inſtance of time. He concludes with noticing two oppoſite hypotheſes, with reſpect to the formation of language. The moſt commonly received of the two, is that language was originally almoſt deſtitute of inflections; and conſiſted chiefly, if not wholly, of monoſyllabic roots, to which human contrivance has gradually given by compoſition, augment, or otherwiſe numerous variations and modifications.

According to the other ſuppoſition language was at firſt polyſyllabic, and the unwieldy long words of which it was made up, words ſignificant of very complicated meanings, were by degrees broken down into ſhorter words. On the former hypotheſis moods muſt have been added to verbs in the courſe of the improvement of language: on the latter they muſt be conceived to be retained in language on account of the peculiar advantages they were obſerved to afford. Thus it appears that both ſuppoſitions are equally indifferent to this theory of the moods of verbs: in tracing out which the object of the author was not to give the hiſtory of the firſt appearance of moods, or to diſcuſs the queſtion, whether they were added to language in its progreſs, or retained in it, when perhaps many other inflections were laid aſide; but has only been to inveſtigate the nature and import of moods more accurately than had been done before, and to ſhew the valuable and almoſt indiſpenſible purpoſes they actually ſerve in the communication of thought.

VII. *An Eſſay on the Character of Hamlet, in Shakeſpear's Tragedy of Hamlet.* By the *Rev.* Thomas Robertson, *F. R. S. Edin.*

IN this attempt to vindicate the conſiſtency of Shakeſpear's Hamlet, the writer conſiders his character before the death of his father, and after that period. The former of theſe, which was his radical and general character, was a compound of high elevation of ſoul, an exquiſite ſenſibility to virtue and vice, and an extreme gentleneſs of ſpirit and ſweetneſs of diſpoſition. To theſe were added, brilliant and cultivated talents, an imagination tranſcendently vivid, an intuitive knowledge of mankind, and a ſingular gayety of ſpirit. How ſuch a character would be affected by ſuch an event as the murder of his father, is the conſideration which affords the eſſayiſt a clue to reſolve the intricacies of his after-conduct and language. In general, it is the vaſt ſcope and variety of his qualities, crowned with a predominant ſweetneſs or gentleneſs of nature, that is brought to account for a ſyſtem of action, which no one leading principle can explain conſiſtently.

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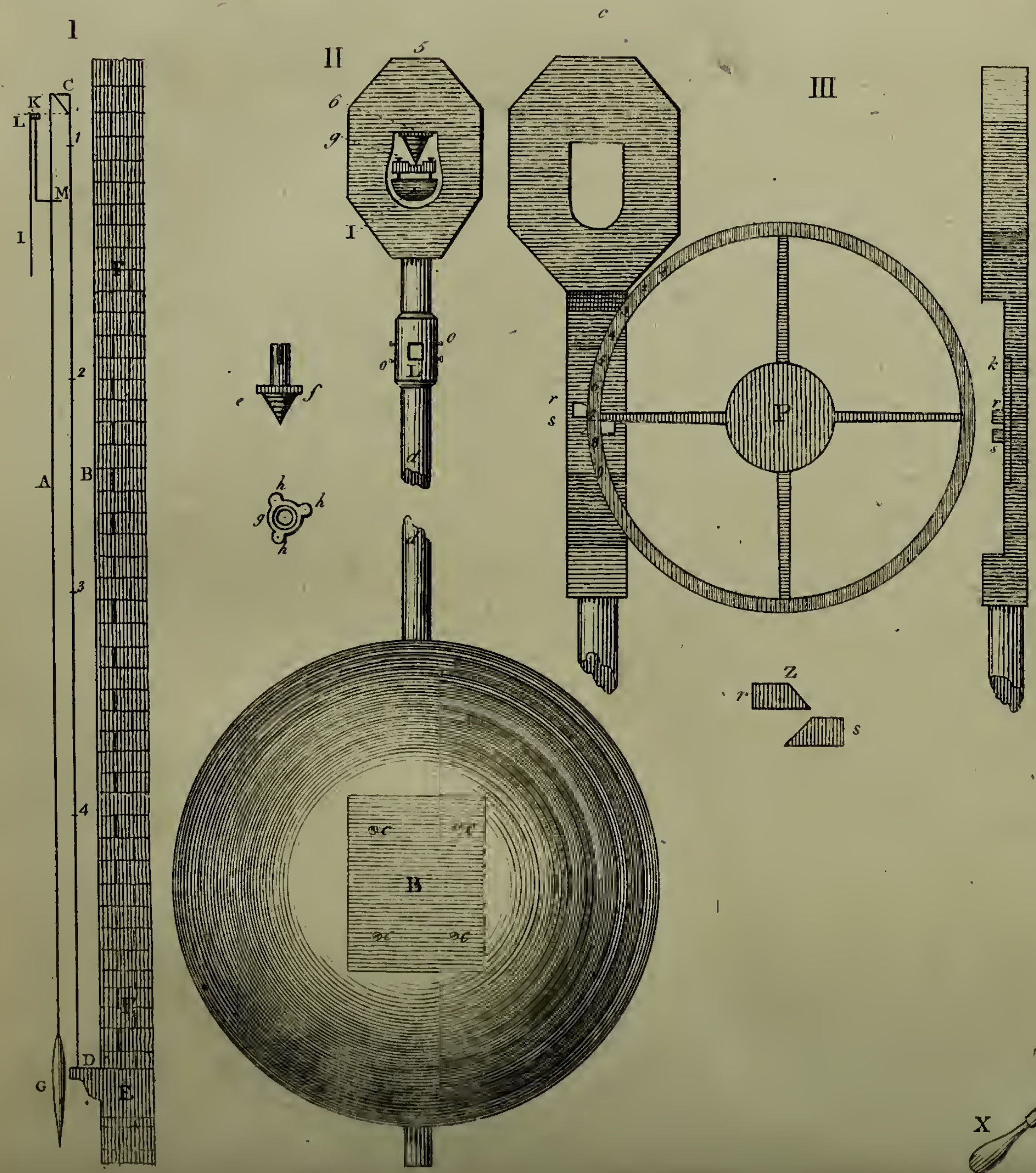
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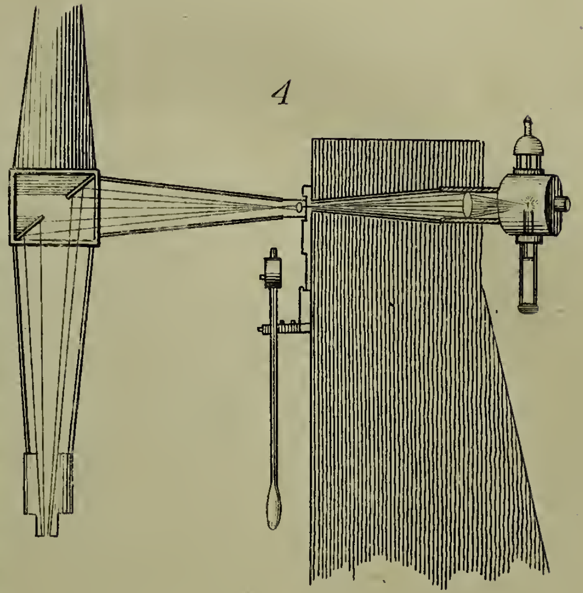
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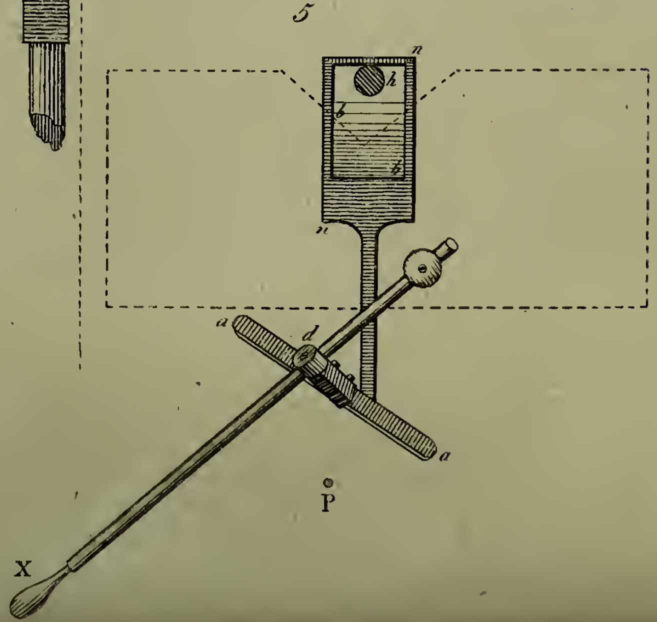
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SCIENCE.

An Account of the moving of a Bog, and the Formation of a Lake, in the County of Galway. By RALPH OUSLEY, *Eſq. M. R. I. A.*

AFTER a remarkably heavy ſtorm of rain, the bog of Addergoole, containing about ten acres, was ſet in motion, overſpread a neighbouring meadow, and ſtopt the courſe of a river, forming a lake of fifty-five acres, which ſtill remains in that ſtate.

An Account and Deſcription of Three Pendulums, invented and conſtructed by JOHN CROSTHWAITE, *Watch and Clock Maker, of Dublin.*

FIG I. plate XIV. repreſents a pendulum with a ſimple mode of compenſation, which has been going eighteen years in very unfavourable ſituations.

A and B are two rods of ſteel forged out of the ſame bar, at the ſame time, of the ſame temper, and in every reſpect ſimilar. On the top of B is formed a gibbet C; this rod is firmly ſupported by a ſteel bracket D, fixed on a large piece of marble E, firmly ſet into the wall F, and having liberty to move freely upwards between croſs ſtaples of braſs 1, 2, 3, 4, which touch only in a point in front and rear (the ſtaples having been carefully formed for that purpoſe); to the other rod is firmly fixed, by its center, the lens G, of twenty-four pounds weight, although it ſhould in ſtrictneſs be a little below it. This pendulum is ſuſpended by a ſhort ſteel ſpring on the gibbet at C, all which is entirely independent of the clock. To the back of the clock plate I are firmly ſcrewed two cheeks nearly cycloidal at K, exactly in a line with the center of the verge L. The maintaining power is applied by a cylindrical ſteel ſtud in the uſual way of regulators, at M. Now, it is very evident that any expanſion or contraction that takes place in either of theſe exactly ſimilar rods, is inſtantly counteracted by the other; whereas in all *compenſation* pendulums compoſed of different materials, however juſt calculation may ſeem to be, that can never be the caſe, as not only different metals, but alſo different bars of the ſame metal that are not manufactured at the ſame time, and exactly in the ſame manner, are found by a good pyrometer to differ materially in their degrees of expanſion and contraction, a very ſmall change affecting one and not the other.

Fig II. repreſents a pendulum, with a diamond ſuſpenſion.—The lens is ſeven inches diameter, made of lead melted into a braſs ſhell, very accurately weighed in all poſitions, turned truly in a very ſteady lathe, firſt flatwiſe, and then on an arbor through its center, and adjuſted ſo that in all ſituations the center of gravity of the lens exactly coincides with the axis of the pendulum rod; a piece of braſs, half an inch thick and three and a half long by two broad, is let into the lead ſo as to be even with its ſurface; four holes being tapped in it to receive the ſcrews *c c c c*, with their heads counterſunk in the braſs ſhell: this piece of braſs is hollowed lengthwiſe on the inſide, ſo as to embrace the pendulum rod, the whole length of itſelf, but moſt ſtraightly at its center. The lens never to be altered after the clock is brought to time. The rod made of red deal, firſt baked, then boiled in linſeed oil for a conſiderable time, and then well varniſhed. On the top is formed an irregular octagon and an opening cut through, of the ſhape of the letter U; there is drilled in the lathe, exactly through its center lengthwiſe, a hole to receive the piece of very hard caſt ſteel *e*, which after being fitted ſquare into a braſs collar *f*, paſſes through the hole in the upper part of the pendulum rod at 5, and is there firmly ſecured by a ſcrew, the head of which is counterſunk in the top of the rod; at 6 the ſteel piece is wrought to a fine conical point, on which the whole pendulum is ſuſpended on the well-levelled face of a large diamond; this diamond is ſet and ſoldered with ſilver into a tempered piece of ſteel *g*, having three levelling ſcrews *h h h*, carefully tapped through it. The points of theſe tempered ſcrews are rounded and lie in beds formed for them in I, a piece of ſteel $\frac{7}{10}$ of an inch broad on the upper ſide; the lower part being rounded, this is very firmly leaded into a piece of ſtatuary marble, about two hundred weight, firmly inſerted in the wall, ſo as juſt to admit the ſteel piece I to paſs through the back of the clock caſe: The pendulum being entirely detached from the clock and ſuſpended on the diamond, and the whole upon the wall. Before the clock was applied, it continued vibrating twenty-ſeven hours in this detached ſtate as a ſimple pendulum. I have applied the maintaining power from the movement by a well-tempered and poliſhed ſteel cylinder $\frac{1}{12}$ of an inch diameter, firmly ſcrewed to the crutch through the opening in the braſs collar L; in this opening I have fixed two pieces of ſapphire, of which this is the ſection , the cylindrical ſides which the hard ſteel cylinder abovementioned acts againſt being well poliſhed, the contact is lineal. To the back of each of thoſe pieces of ſapphire I have fitted two ſcrews *o*, *o*, tapped through the braſs collar L, which firmly embraces the pendulum rod. By theſe ſcrews the pieces of ſapphire are accurately adjuſted to the ſteel cylinder, ſo that the power is applied, without the ſmalleſt ſhake or loſs of force, exactly in the line of the centers of oſcillation, gravity and ſuſpenſion.

An account of a clock where the maintaining power is applied immediately from the eſcapement wheel to the axis of the pendulum rod, without verge, crutch, or any other agent.—I cut a notch in the pendulum rod deeper than its axis, (ſee the profile, Fig. III.) and in that opening at *k*, and in that part on a plate of braſs fixed firmly by ſcrews, two pallets *r* and *s*, repreſented larger at Z below, and by the eſcapement wheel P, with pins 1, 2, 3, 4, 5, 6, &c. made of very hard drawn braſs wire inſtead of teeth, I applied the maintaining power exactly in the line of the centers of magnitude, oſcillation, ſuſpenſion, motion and gravity. This appears to me the moſt ſimple and perfect method of applying the maintaining power to pendulums that has hitherto been thought of, and if perfectly executed with ruby or ſapphire pallets, and hard ſteel pins well finiſhed in the wheel, the point of ſuſpenſion made pefectly immoveable, and the maintaining power perfectly uniform, then perhaps the faireſt trial may be given to different pendulums.

An Account of a new Method of illuminating the Wires, and regulating the Poſition of the Tranſit Inſtrument. By the Rev. HENRY USSHER, *D.D. S.F.T.C.D. M.R.I.A. and F.R.S.*

DR. USSHER obſerves that there are ſome particulars in the tranſit inſtrument in Trinity College, Dublin, which it is the intention of this paper to explain. The entire light of the object glaſs is preſerved by a moſt ſimple contrivance:—

That pivot of the axis which reſts upon the plate that regulates the motion in azimuth, is perforated with a ſmall hole, and in this is inſerted a convex lens; the plate and the pillar are perforated alſo in the direction of the axis; the perforation in the pillar near the back part is three inches in diameter; in this is inſerted a tube carrying another larger convex lens; to this tube is attached the lantern, in which the flame of the candle is kept always oppoſite the axis of the tube by means of a ſpring ſocket.

The rays of light iſſuing from the candle are by theſe lenſes brought to a focus immediately beyond the ſmall lens inſerted in the pivot, and diverging from thence, within the conical axis, are intercepted at the ſquare box in the centre by a diagonal plate of ſilvered braſs, which reflects the light down to the wires; this plate is perforated with an elliptical hole, to let the cone of rays from the object glaſs paſs through undiminiſhed. See Plate XIV. Fig. 4.

To temper this light in proportion to the ſtar obſerved, there is a green glaſs increaſing gradually in depth of tint from the top to the bottom: this glaſs is ſet in a braſs frame, which ſlides in a dovetail between the azimuth plate and the pillar; and the elevation or depreſſion of this is regulated by a lever, the arm of which is readily brought to the hand in any poſition; this lever conſiſts of two ſeparate arms, which are preſſed together by ſcrews, and each turn upon one pin inſerted into the pillar: by lightening the ſcrews the friction of the arms againſt each other may be ſo increaſed, that when the longer arm is moved the ſhorter one moves with it, and raiſes or lets down the glaſs-frame; when this is raiſed to the greateſt height, then the ſhort arm preſſes againſt the bottom of the azimuth plate, and any additional force now applied overcomes the friction at the centre; ſhould the motion of the arm be required in the oppoſite direction, this is effected by making the ſhort arm preſs againſt a pin placed below it, with a ſimilar effect to the former, the force applied overcoming the central friction as above; and thus the long arm may be brought parallel to the teleſcope in whatever poſition it is ſet for obſervation.

Plate XIV. Fig. 5. repreſents the lever and glaſs-frame; the azimuth plate is repreſented by dotted lines. If it be required to move the long arm from the poſition there repreſented to a vertical ſituation for an obſervation in the zenith, then by depreſſing the handle *x*, the ſhort arm *a*, *a* is raiſed and puſhes up the the glaſs-frame, until *a*, *a* preſſes againſt the bottom of the azimuth plate, where as it can go no higher, any additional force in that direction overcomes the friction at the central pin (*d*) and the long arm is readily brought into a vertical poſition, the ſhort one remaining at the azimuth plate; and in this new poſition, the lever has the ſame power of regulating the deſcent of the frame as before: if it be required to put the arm into an horizontal poſition, the preſſure of the ſhort arm againſt the pin (*p*) inſerted in the pillar below it, overcomes the central friction in this direction; *h* repreſents the hole in the pillar through which the light comes; *n*, *n* the braſs frame; *b*, *b* the green glaſs.

In juſtice to Mr. Ramſden I muſt obſerve, that it was not without ſome difficulty that I prevailed upon him to introduce this mode of illumination in this inſtrument, he being juſtly cautious leaſt the heat of the candle might have any effect on the axis; but ſeveral hours carefully employed by him and me in critical experiments, ſatisfied him fully that his fears were groundleſs, and I can now by experience of the inſtrument pronounce them ſo.

This mode of illumination has many advantages. Firſt, the object is not rendered

tremulous

tremulous by the vapor and flame of the candle decompoſing the air at the object glaſs. Secondly, no part of the light afforded by the object glaſs is loſt. Thirdly, you can diminiſh your aperture at pleaſure without the trouble of altering your illuminator; whereas if the annular one be applied a different elliptic ring muſt be provided for every diminution of aperture; if the ſolid illuminator be uſed, you cannot diminiſh the aperture very much, and preſerve the valuable central rays. Another uſe of this method has occurred to me ſince I began to apply it, which is this—by accurately dividing the ſtem of the glaſs-frame, and removing the green glaſs, we might more certainly determine the different magnitude of the ſtars, by noting the quantity of light neceſſary to efface them.

But the principal improvement in this inſtrument is an invention that does high honour to Mr. Ramſden, and is a moſt valuable acquiſition to all aſtronomical inſtruments where plumb lines are introduced, viz.

The Method of adjuſting the Horizontal Poſition of the Axis.

Every one muſt allow, that the adjuſtment by the ſpirit level is of all modes the moſt convenient, but it is not without its defects; there are few levels true to leſs than two ſeconds in winter, when all levels are moſt ſluggiſh; add to this, that the pivots of the axis muſt, for this adjuſtment, be accurately of equal diameters, and perfect cylinders; we muſt alſo take into account the danger of any partial heat reaching the glaſs tube, which will create an enormous error.

To remedy theſe defects, a plumb-line has been ſubſtituted, but generally not well contrived. The uſual adjuſtment by the plumb-line has been, to attach two ſmall pins to the tube of the teleſcope, one near the object glaſs, the other near the eye end of the tube, and to make a plumb-line, ſuſpended from one of theſe, paſs over and biſect two fine points, one near each end of the tube; then, inverting the teleſcope, and ſuſpending the plumb-line from the other pin, to ſee whether it biſect the ſame points again; and if not, to correct half the error in the uſual manner: but this appears to be dangerous to the line of collimation.

My firſt attempt at adjuſtment by the plumb-line in the year 1774, was to ſuſpend a braſs rod by hooks on the pivots, like the horizontal bar of a level, and to the middle of this I attached a vertical bar with two fine points, and a plumb-line; but this was ſubject to inaccuracy, unleſs the pivots were preciſely of equal diameters. I then contrived that the bar ſhould not hook on the pivots, but be preſſed upwards by a ſpring againſt their under parts.

Although this adjuſtment was independent of all inequality in the pivots, yet it was objectionable, becauſe during the adjuſtment there was the weight of the tool on the axis, from which it was diſengaged in the act of obſervation; whence the inſtrument was proved and applied in diſſimilar circumſtances. But whilſt I had this tool actually in hands, the following elegant and unobjectionable mode was deviſed by Mr. Ramſden, which immediately made me lay aſide all thoughts of the former; and in fact I know of no late invention that ſeems to promiſe more towards the improvement of all aſtonomical inſtruments where plumb-lines are applied.

In one ſide of the tube of the teleſcope, and twelve inches from each end of it, he makes a ſmall hole, and inſerts a very thin ſemipellucid bit of ivory, with a black dot in the center; in the other ſide of the tube, oppoſite to each of theſe, he inſerts a convex lens; now it is obvious that an image of each dot will be formed in the conjugate focus of its correſponding lens. The tops of the pillars ſupport a braſs frame, carrying a plumb-line and two microſcopes, placed directly before the images of the dots, to which their foci are adjuſted, ſo that the images are diſtinct and magnified; and the plumb-line being moveable by ſcrews at the ſuſpenſion frame above, is made to ſwing through theſe images. Nothing can be better imagined than this.

In the firſt place, the adjuſtment is applied totally independent of the inſtrument; and ſecondly, the plumb-line hanging in the images themſelves, there cannot poſſibly be any parallax on the wire, nor any corpuſcular attraction exerted on it, as is probably the caſe when a plumb-line is brought very near to a metallic plate; inconveniences to which all plumb-lines have hitherto been in ſome degree ſubject.

Plate XV. Fig. 1. ſhews a ſkeleton of the adjuſting tool parallel to the teleſcope B B, which during the adjuſtment is always in a vertical poſition, in one end of the horizontal arm C L, is cut notches which reſts upon a priſmatic bar of braſs placed on the top of each pillar, and in the direction of the miridian. The horizontal poſition of theſe bars is obtained by common adjuſtments for ſuch purpoſe. The extremity of the other end of the horizontal bar by C, reſts upon the point of a vertical ſcrew which works in a cock ſcrewed on the top of each pillar, *d d* is a ſilver wire ſupporting the plummet (*p*) which ſwings on a glaſs veſſel filled with water, as is uſually done to check the vibration, X Z are two microſcopes; at *e* is an adjuſtment ſuch as is commonly uſed to bring the wire in the focus of the microſcope; and to draw the wire eaſt or weſt, oppoſite the dot. W is a pinion which works in a rack that ſupports the glaſs veſſel filled with water; by means of this the veſſel can be raiſed ſo as to relieve the wire from the weight of the plummet when the machine is moved.

Fig. 2. is the ſame in profile. Q, Q are the dots; *o*, *o* the lenſes, by means of which the images of the dots are formed in the conjugate foci at S, S; theſe images are diſtinctly ſhewn by the microſcopes X Z; the plumb-line is made to ſwing through one dot by means of the ſcrews at the top of the adjuſting tool; whilſt the other dot, which is moveable from right to left, has its image brought to the wire by means of a ſcrew. We now ſuppoſe that the plumb-line ſwings through the center of each image, and the true poſition of the tool is ſo far obtained, provided the plummet hangs freely in the middle of the glaſs veſſel, which will be the caſe when the arm, which reſts upon the priſmatic bar, that is, when the bar itſelf is horizontal. Provided alſo that the other arm is truly horizontal, which poſition is obtained by the ſcrew, which works vertically in the cock by C.

The juſt diſtance of the tool from the teleſcope is ſhewn by the diſtinct viſion of the images; and in order to obtain the ſame diſtance exactly at all times, a ſcrew which works in a cock, ſcrewed to the priſmatic bar is moved, 'till its point juſt preſſes againſt the end of the notched piece which reſts on the bar. Let now the ſcrew W at the bottom be turned, ſo as to relieve the plumb-line, and let the tool be removed; then let the teleſcope be inverted, and the tool brought to the other ſide, and placed upon the other bar and cock, let the wire be made to ſwing through and biſect the upper image; if now the teleſcope has turned upon an axis truly horizontal, the plumb-line will alſo biſect the lower image; if not, correct half the error as uſual, and repeat the adjuſtment 'till all error vaniſhes.

Thus we ſhall have the inſtrument proved, without any additional weight on the axis; we have the advantage of a long plumb-line, without parallax, or corpuſcular attraction; and all error of the artiſt in the diameters of the pivots is rendered of no conſequence whatever.

Apparatus for reverſing the Inſtrument.

As the line of collimation requires conſtant verification, the reverſing of the axis ſhould be rendered as commodious as poſſible; particularly as this is always done to the greateſt nicety by celeſtial obſervations, which will not admit of delay. I always prove it by the polar ſtar*, and this is the method: I obſerve the paſſages over the three firſt wires; I then reverſe the inſtrument, and take the paſſages over the two laſt wires, that is, in fact over the two firſt again. Now it is manifeſt, that if the collimation be perfect, the intervals from the firſt wire to the middle one, and from the middle one to the fifth, will be preciſely equal, as alſo the intervals from the ſecond to the middle, and from the middle to the fourth. The apparatus for this purpoſe, ſhewn in Plate XV. Fig. 2. is ſo manageable, that I can reverſe this weighty inſtrument without help in the ſhort half paſſage of Urſæ minoris, in time to obſerve the paſſage over the laſt wire, having before reverſing obſerved the paſſages over the firſt, ſecond and middle wires. The horns E, E, being placed under the axis: the winch A is turned, which works with a double pinion in the rack B, which is double, having the teeth ſet at alternate intervals, as ſhewn in Fig. 3. by which means the ſmootheſt motion poſſible is obtained: this rack elevates the block C, hollowed conically to receive the extremity of the cylinder D, made to fit it; and this raiſing the upper work on which the axis now reſts, lifts the inſtrument off its ſupports, which is then readily turned round on the cylinder D, working in the cone C and female cylinder F, F; and may be then, in its reverſed poſition, ſmoothly and gently lowered down again to its ſupports.

An Eſſay to improve the Theory of Defective Sight. By the Rev. JOHN STACK.

THE common theory of defective ſight attributes the confuſion in imperfect viſion to the interſection of the rays of each pencil that enters the eye, in points either *before* or *behind* the retina. It ſtates the former of theſe defects as proceeding from too great a convexity of the cornea, or of the chryſtalline humour, or of both; and the latter from the contrary ſtructure of thoſe parts of the eye. Beſide theſe, ſcarce any other cauſes are aſſigned, or any farther explanation of the defects given. This, however, ſeems inadequate to the ſolution of ſeveral peænomena in caſes of defective ſight that frequently occur; ſuch as the following:

1. I have frequently cauſed ſhort-ſighted perſons to place a printed book a little beyond their limits of diſtinct viſion; then applying a card, with a ſmall hole made in it, to the eye, they read at the above-mentioned diſtance with great eaſe.

2. Obſerving

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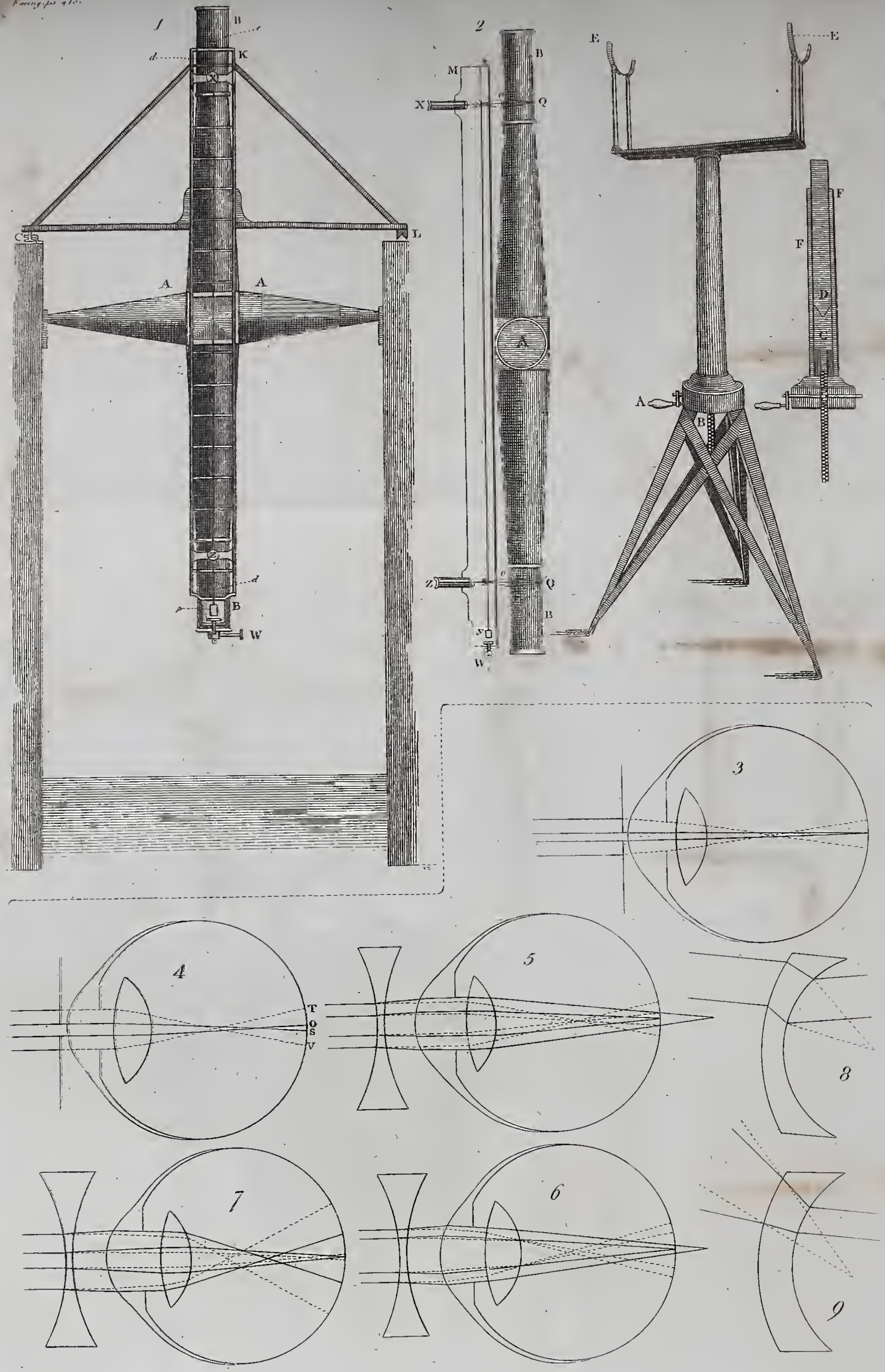
* The reaſon why I prefer the polar ſtar is, becauſe the ſmalleſt error in the collimation will, on account of the ſlow motion of this ſtar, ſhew a difference which cannot be attributed to the unavoidable error of obſervation, or caſual irregularity of the clock; at leaſt we know the limit by practice.

Plate XV



2. Obſerving the effect of this experiment to be more ſtriking than uſual in a perſon, the pupil of whoſe eye was very large, I meaſured the diſtances at which he could read when the pupil was dilated, and when it was contracted, and found the former leſs than the latter by about two inches.

N. B. Theſe caſes are the more remarkable, as the quantity of light incident from the object on the eye is diminiſhed in each of theſe experiments,* and conſequently the vividneſs of the pictures on the retina; therefore a conſiderable degree of diſtinctneſs muſt have been procured to overbalance the diſadvantage that the loſs of light occaſioned.

3. I have met with caſes, though not frequently, of defective ſighted perſons whoſe ſight was ſuch as to be incapable of being aſſiſted by any double-concave or convex glaſſes. Some of them found viſion a little more diſtinct through a pin-hole *in ſtrong light*, others not.

Theſe caſes do not appear at all explicable on the vague theory of defective ſight generally received; and perhaps others of a ſimilar deſcription may occur, or have already occurred to more accurate and extenſive enquirers.

That ſuch phænomena however may reſult from various defects in the ſtructure of the eye, will be evident to any one who conſiders the exact conformation and adjuſtment of its parts neceſſary to produce perfect viſion. Theſe requiſites indeed are ſo many, and of ſo ſubtile a nature, that it ſeems much more ſurpriſing that ſo delicate an organ ſhould not be oftener rendered imperfect by accident or natural infirmity, than that ſo many inſtances of defective ſight ſhould be met with.

A deviation from the juſt form or refractive power of any of the different humours might be ſhown (from optical principles) capable of cauſing the phænomena abovementioned; but as the chryſtalline humour is the principal inſtrument in viſion, it will be ſufficient to point out the effects ariſing from any deficiency in its ſtructure, eſpecially as the number and minuteneſs of the circumſtances neceſſary to its perfection make this humour more liable to incur the defect than either of the others; and as any remedy applicable to the removal of errors hence ariſing will be found equally ſo to that of errors occaſioned by the imperfection of the aqueous or vitreous humours.

The chryſtalline humour being in the form of a double-convex lens, it is evident that when parallel rays are incident on it, thoſe fall more obliquely on its ſurface which are more remote from the vertex or middle point of that ſurface. Now if that humour were of uniform denſity, the refraction of the remote rays would ſo far exceed that of the central ones as to interſect each other nearer to the chryſtalline than the mutual interſection of the more central rays; therefore if one of theſe interſections (or foci) be at the retina, the other muſt be removed from it, and conſequently a confuſion would enſue in the picture on the retina.

It is however well known that nature has uſed an admirable precaution againſt this imperfection, by gradually diminiſhing the denſity (and therefore the refractive power) of the chryſtalline from the center toward the edges; ſo that the exceſs of refraction ariſing from obliquity of incidence ſhould ſerve as a compenſation for the defect of it, owing to the diminution of denſity, and thus *in perfect viſion* produces this effect, that both the extreme and central rays of the incident pencil ſhould be brought to a common focus exactly on the retina.

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* Hence the reaſon why theſe experiments are attended with more remarkable effects in ſtrong than in weak light.

Let us now ſuppoſe a chryſtalline humour of ſuch a form as it uſually has in a perfect eye, and at the central parts of a juſt denſity, but whoſe denſity is not ſufficiently dimiſhed in proceeding from the center to the edges: from what has been juſt obſerved on the caſe of uniform denſity in the chryſtalline, it is plain that the exterior rays of the incident pencil, and thoſe only, will in the preſent caſe ſuffer too great a refraction, and produce confuſion in the picture on the retina; conſequently if theſe be intercepted, and the central rays alone tranſmitted to the eye (as is done in the firſt experiment by the pin-hole) viſion will be diſtinct, and no obſtacle to its perfection will remain but what ariſes from want of ſufficient light. Vid. Plate XV. Fig. 3.

Even though the denſity of the chryſtalline were every where too great as well toward the center as toward the edges, yet as the diffuſion O S, occaſioned by the central rays, is far leſs than T V, that cauſed by the exterior rays, viſion, though not rendered perfectly diſtinct by the excluſion of the exterior rays, will be made more clear than before, unleſs the denſity be very much greater than it ſhould, in which caſe the diffuſion O S might be ſo great as to impede viſion entirely, as well as the diffuſion T V, which is greater than it. Vid. Fig. 4.

I have here ſuppoſed the rays parallel, for the purpoſe of conſidering the view of remote objects; but the reaſoning will equally apply to rays ſenſibly diverging, and ſo will illuſtrate as well the view of nearer objects.

Theſe obſervations, if juſtly founded, might ſerve to ſhew the reaſon of what occurred in the ſecond experiment, where the confuſion of viſion was ſo much diminiſhed by the contraction of the pupil, the iris in ſuch a caſe intercepting thoſe rays which cauſed a confuſion when the pupil was dilated; in the ſame manner as the card in the firſt experiment intercepted the rays that cauſed confuſion to the naked eye.

It appears to me that the defect of all ſhort-ſighted perſons who are aſſiſted by concave glaſſes is probably of that kind repreſented in Fig. 4, becauſe as the refraction of a lens affects any rays that fall on it (except that in its axis), and as the refraction is conſtantly greater the more remote the incident rays are from the axis, ſo where ſuch a glaſs renders viſion diſtinct, errors of refraction muſt have taken place in the eye, previous to the application of the glaſs, equal and contrary to thoſe refractions which have removed them.

If the defect were not of this nature, but that all the rays were brought to a focus in the ſame point before the retina, a lens, the refraction of whoſe central parts would bring the rays near the axis to a focus at the retina, will, by the greater refraction of its exterior parts, remove the focus of the more remote rays behind the retina. Vid. Fig. 5. Or even though all the rays did not meet in a point, yet if their interſections were all very cloſe to each other, and at a conſiderable diſtance from the retina, the effect of a concave glaſs would be the ſame as before; and while it deſtroyed the diffuſion of the central rays, would leave a diffuſion of the exterior rays remaining, or vice verſa. Vid. Fig. 6.

On the other hand, if the foci of the extreme and central rays within the eye fall before the retina, and are two diſtant from each other, no double concave of the uſual form (*i. e.* of equal curvature on each ſide) can deſtroy the error of the one kind of rays, without generating or leaving one of the other kind. Vid. Fig. 7.

Now, if any glaſs can be contrived in which the quantity of refraction of the central rays can be made the ſame as in a double concave, while that of the exterior rays is diminiſhed, it would ſeem that the former error might be avoided; and on the contrary, that the laſt mentioned error might be compenſated, if the glaſs were ſo contrived as to make the exterior rays ſuffer a greater refraction than they do in the double concave, the refaction of the central rays remaining the ſame as before. And perhaps it will appear that theſe effects may be produced by a concavo-convex glaſs of greater curvature on the concave ſide than on the convex, eſpecially if the thickneſs of ſuch a lens be made greater than uſual; becauſe the thicker the lens is, the nearer will an exterior ray be brought to the vertex of the ſecond ſurface, and therefore its incidence, and conſequently its refraction by that ſurface, will be the leſs, as in Fig. 8.; vice verſa in Fig. 9.

We ſee that in the double concave the refraction of an exterior ray, by the firſt ſurface, is greater than that of a central ray, and as its effect is to cauſe a divergence, the refraction of the firſt ſurface will add more to the effect of the ſecond ſurface (which is alſo to cauſe divergence) upon the exterior rays than upon the central.

1. In the ſame manner in the concavo-convex (the rays falling on the convex ſide) the refraction of the exterior rays by the firſt ſurface is greater than that of the central rays; but theſe refractions are decrements of the divergence cauſed by the ſecond ſurface; therefore the divergence of the exterior rays is more diminiſhed than that of the central rays, and therefore may be made leſs than that of the exterior rays made by a double concave, while the divergence of the central rays cauſed by both is the ſame.

2. Let the rays fall on the concave ſide, Fig. 9. In this caſe the divergence of the exterior rays by the concave is greater than that of the central rays; hence the incidence of the exterior rays on the ſecond ſurface may be made leſs than that of the central rays; and therefore the refraction of the former ray into air may be leſs than that of the latter; that is (ſince theſe refractions cauſe a convergence) the divergence of the exterior rays is leſs diminiſhed than that of the central, therefore the exterior rays will for both reaſons diverge more than the central.

This, it will be ſaid, is equally effected by a double concave; but if the curvature of the firſt ſurface in the concavo-convex be conſiderable in reſpect of that of the ſecond ſurface, it may be brought to paſs that the incidence of the exterior rays on the ſecond ſurface ſhall be of a different affection from that of the central rays, and therefore that the refraction of the ſecond ſurface may augment the divergence of the former, while it diminiſhes the divergence of the latter, and thus cauſe a greater divergence of the exterior rays than can be effected by the double concave, while the divergence of the central rays cauſed by both is the ſame.

Theſe expedients ſeem capable of correcting the unuſual errors of ſhort ſight, that cannot be removed by any double concave glaſs, if they ſhould be occaſioned by the cauſes that I have ſuppoſed, *i. e.* by conſiderable errors of ſphericity.

And it ſeems probable, from what has been ſaid, that ſuch defect is occaſioned by thoſe cauſes, where perſons of the above deſcription are aſſiſted in viſion by looking through a pin-hole, and that they may try the effect of the concavo-convex poſſibly with advantage.

And if any chromatic errors ſhould accompany theſe errors of ſphericity, as probably there would, they will be diminiſhed or removed by the diſperſion that attends the refraction of the glaſs.

But where the application of a pin-hole to the eye does not render viſion more diſtinct, the defect probably does not riſe from ſuch imperfect ſtructure* of the eye as has been ſuppoſed, but from ſome other cauſe, as turbid humours, calloſity of the retina, or reflection of the oblique rays from the ſides of the eye, by which the pictures on the back part of the retina would be confuſed.

Dr. Porterfield and others account for the diſtinctneſs afforded to ſhort-ſighted perſons by looking through a pin-hole, by the diminution of the breadth of the pencil incident upon the retina, ſuppoſing ſtill that all the rays *interſect in one point within the eye*; but beſide that the breadth is not ſo much leſſened on that hypotheſis as on the hypotheſis here given, and therefore the phænomenon not ſo adequately accounted for, it alſo ſeems a very extraordinary and improbable ſuppoſition, that while all the numerous parts of ſo delicate an organ as the eye are diſordered or deranged, yet that ſo exact a *harmony in error* ſhould be obſerved among them, as to bring the rays of every different poſition to one common interſection at an improper place.

An Account of ſome Obſervations made with a View to aſcertain whether Magnifying Power or Aperture contributes moſt to the diſcerning ſmall Stars in the Day. By the Rev. HENRY USSHER, *D.D. M.R.I.A. and F.R.S.*

IT has long been a diſputed point amongſt aſtronomers, nor is it, I believe, yet decided, whether aperture or magnifying power contributes moſt to the diſcerning ſmall ſtars in the day.

The following experiments and obſervations, made with the tranſit inſtrument of our obſervatory, may perhaps tend to throw ſome light on the ſubject: they were made with care, and are certainly related without prejudice, for the concluſion I arrive at, is contrary to what I ſuppoſed previous to experiment.

The diameter of the object-glaſs is $4\frac{2}{10}$ inches. I made three diaphragms of paſteboard, with apertures whoſe diameters were inverſely proportional to the ſquare roots of the magnifying powers; and by means of theſe I could compare ſeverally 600 and 200, 400 and 200, and 600 and 400; although, as remarked above, theſe compariſons are not exactly juſt.

Things being in readineſs, I began my experiments on December 2d; and in theſe I did not depend ſolely on my own eye; I thought it better to put them to the teſt of eyes leſs uſed to aſtronomical obſervation, yet ſufficiently acquainted with the practice, to find ſmall ſtars in the field of view.

θ Bootis of the fourth magnitude paſſed 2*h.* 12′ before the ſun: this ſtar was viſible with 200, but incomparably better with 600 with the diminiſhed aperture; it appeared with a planetary roundneſs. This trial was made by me.

β Urſæ minoris, to an unpracticed eye, appeared confeſſedly better with 600 than 200.

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* It is poſſible that the ſtructure of the eye might be ſuch as that the foci of the exterior and central rays would fall at different ſides of the retina, which defect would not eaſily be remedied; but even this I conceive might be accompliſhed by combinations of different lenſes, like the compound object-glaſſes of Dolland.

Second γ Urſæ minoris paſſed 1 *h.* 7′ before the ſun. The ſame eye gave the ſame concluſion.

γ Serpentis 3d magnitude paſſed 52′ before the ſun: not viſible to me with 200 and whole aperture; ſeen with 600, and the proportional diminution of aperture; and ſhewn to another perſon; ſought for again with 200, but in vain.*

θ and η Draconis, both of 3---4 magnitude; the latter paſſed 12′ 32″ before the ſun; viſible with both powers, but far better with 600 to an eye that had ſome practice, and alſo to me.

December 4, ſecond γ Urſæ minoris, not diſcoverable with 200, plainly ſeen with 600 by an eye totally unuſed to obſervation.

δ Draconis, not viſible to the ſame with 200, ſeen plainly with 600; afterwards diſcovered with 200, but with difficulty.

N. B. This day was a little hazy, with thin clouds, through which both by night and day the 600 had the advantage, and ſhewed to my eye many ſtars that were inviſible with 200. I mention this, becauſe I at firſt ſuſpected, that although the great power had the advantage in the clear blue ſky of December 2d, yet perhaps it might be inferior in another ſtate of the air, by magnifying the haze and vapors; but the obſervation of γ Serpentis in the glare of the ſun on the 2d, and many ſtars both by night and day on the 4th, confirm the ſuperiority of 600.

I next prepared a ſet of diaphragms whoſe areas of aperture were inverſely proportional to the magnified area of the object.

December 12th, β Urſæ minoris diſtinct and magnified with 600; diſtinct alſo but not magnified with 200; this ſtar is too bright for any concluſion to be drawn.

1ſt γ Urſæ minoris, a very ſmall ſtar, viſible with 600, with its proportional aperture; inviſible with 400.

Many other trials proved the ſuperiority of the great magnifying power with diminiſhed aperture: I cannot omit mentioning one more.

December 29th, β Lyræ paſſed 7′ after the ſun; this ſtar, of the 3d magnitude, and ſo near the ſun, I had little expectation of ſeeing. I ſought it in vain with 200 and 400, but ſaw it plainly and obſerved its paſſage with 600, having an aperture rather ſmaller than juſt proportion demanded. I ſhewed the ſtar to another perſon before it quitted the field of view.

For the ſuperiority of magnifying power the following cauſes may be aſſigned:

The principal one, perhaps, is the quickneſs of the ſtar's motion in the field of view. That this contributes to perception I collect from hence; that when a ſtar, although within the field, does not immediately preſent itſelf to the eye, as is ſometimes the caſe with Jupiter near the ſun, if the teleſcope be gently moved, the apparent motion of the ſtar immediately diſcovers its place.

Another reaſon may perhaps be the magnified image of the ſtar which thus becomes a more perceptible object, even though its light is diminiſhed; this amplification, as far as I can perceive, is nearly in the inverſe proportion of the aperture; in very conſiderable diminutions at leaſt, it ſeems to follow this proportion: thus with an aperture $\frac{3}{10}$ of an inch the polar ſtar took 64″ to paſs the wire: with one of $\frac{6}{10}$ 32′,5: but with $\frac{9}{10}$ 30′, and with 2,8 inches 19″.

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* This ſtar was very near the ſun, and its being viſible is a ſtrong proof of the excellence of this inſtrument.

I at firſt ſuſpected that this amplification aroſe from ſome unavoidable error in the object-glaſs, which created a circle of diſſipation around the principal image, which circle became viſible in proportion to the darkneſs of the field; but by the following experiment it ſeems to ariſe from the inflexion of light. I made a rectangular aperture $\frac{3}{10}$ of an inch broad, and $\frac{6}{10}$ long; when this aperture was applied vertically, it gave me an eliptical horizontal image; and when applied horizontally, it gave me an eliptical vertical image. Alſo when I applied a triangular aperture, it gave an image nearly the ſhape of a pear; the broad end being formed by the vertex, and the narrow end by the baſe: the triangle was formed with a long baſe and ſmall altitude, ſo that the effect of the other angles on the image became inſenſible to the eye.

I ſhall conclude with pointing out an advantage that I reap from this circumſtance: By means of a conſiderable diminution of aperture, I make the polar ſtar ſo diſtinctly round and large, that I obſerve the appulſe of its limbs to each edge of the wires, as well as the paſſage of its center over them; by which means much greater preciſion is obtained in proving either the collimation or meridian.

An Eſſay on the Variations of the Barometer. *By* RICHARD KIRWAN, *Eſq. M. R. I. A. and F. R. S.*

THE writer begins with remarking, that though the variable height of the mercury in the barometer is without doubt the immediate conſequence of the variable preſſure of the atmoſphere, yet that the cauſe of this variable preſſure has not yet been aſcertained. He then proceeds to ſtate, firſt, the principal obſervations made on barometrical variations.

Obſer. 1. The more conſiderable elevations and depreſſions of the mercury happen in a very ſhort interval of time in places very remote from each other. Various inſtances of this correſpondence are produced, but they are found not to happen where there is a conſiderable difference in longitude.

Obſer. 2. The deviations of the mercury from its mean annual altitude are far more frequent and extenſive near the poles, than near the equator.

Obſer. 3. The variations without the tropics are greater and more frequent in the winter than in the ſummer months.

Obſer. 4. The variations are conſiderably ſmaller in very elevated ſituations than on the level of the ſea.

Obſer. 5. The mean height of the barometer on the level of the ſea in moſt parts of the globe is found to be about thirty inches.

Obſer. 6. In calm weather, when the air is inclined to rain, the mercury is commonly low.

Obſer. 7. Upon very high winds, though not accompanied with rain, the mercury ſinks loweſt, having regard to the quarter from whence the wind blows.

Obſer. 8. In ſerene and ſettled weather the mercury is generally high, as alſo in calm and froſty weather.

Obſer. 9. The greateſt heights of the mercury are found upon eaſterly and north eaſterly winds; to which we may add, that under a ſoutherly wind it is commonly low. The four laſt obſervations are Dr. Halley's, made in England, but found to apply to more ſouthern latitudes.

The writer next proceeds to the cauſes to which theſe phænomena have been aſcribed.

1. *On the influence of different temperatures.* Though cold condenſes and heat rareſies the air, yet while the maſs of the atmoſphere remains the ſame, its weight will be unaltered. Now, obſervation ſhows, that a variation of the maſs is not a neceſſary conſequence of the change of temperature, the height of the mercury being often the ſame in different ſeaſons and under different climates. Further, great changes of temperature take place only in the lower regions of the atmoſphere; any increment or decrement in the maſs of which, from that cauſe, will be too inconſiderable to alter materially the height of the barometer. This is proved by a calculation.

2. *On the influence of winds.* Dr. Halley attributes the riſe of the mercury to the accumulation of air over the place, proceeding from two contrary winds blowing thither; but were this the caſe, we ſhould always have a calm when the mercury ſtands higheſt, which is not the fact. In purſuance of the ſame hypotheſis he aſcribes the fall of the mercury to the exhauſtion of air by two contrary currents; but this ſeems an impoſſible ſuppoſition, ſince in that caſe the air on each ſide would flow in to maintain the equilibrium; or the higher air would deſcend, and cauſe a ſenſible cold, which is not obſerved to take place when the barometer is low. Halley further aſcribes the great deſcent of the mercury in ſtorms to an attenuation of the air, owing to its being carried away by the current of wind faſter than the ſtagnant air behind and on the ſides can ruſh in to ſupply its place; but the fact is, that the fall of the mercury is previous to the ſtorm, and that during the rage of it, a riſe commonly takes place. Further, the velocity of the ſwifteſt wind is vaſtly inferior to what would be required to make a vacuum of air.

3. *On the influence of vapours.* The writer ſtates Mr. Sauſſure's doctrine concerning the preſence of vapour in the atmoſphere, and its properties; and from calculation infers that the difference of weight in a column of air paſſing from perfect dryneſs to ſaturation with moiſture, would not exceed $\frac{1}{10}$ of an inch of the barometer; and therefore the ſaturation of the atmoſphere with vapour if admitted in the greateſt degree will not account for the fall often obſerved in the mercury.

4. *Of the unequal diffuſion of the higher atmoſphere.* This appears to the writer to be the only cauſe adequate to the effects produced, viz. the accumulation of air over certain parts of the globe, and its ſubtraction from others. The weight of the atmoſphere proceeding from the mixed ratio of its denſity and height, to produce equality of weight, it ſhould be loweſt where its denſity is greateſt, and higheſt where it is leaſt. Theſe extremes of denſity take place in the equatorial and polar regions, the former being the leaſt, the latter the moſt, denſe. But the mercurial heights at the level of the ſea being equal, the maſſes of the correſponding atmoſpheric columns muſt be ſo; whence in order to balance the rarefaction of the lower part of the column in the equatorial regions exceeding that in the polar, the ſuperior part of the equatorial column muſt be denſer than the polar; on this account, the upper columns of equatorial air not being ſupported by an equal denſity in the collateral columns of extratropical air, the air gradually flows over, and rolls to the north and ſouth. Theſe ſuperior tides conſiſt chiefly of inflammable air, which is much lighter than any other, and is abundantly generated between the tropics. It furniſhes the matter of the *Aurora Borealis* and *Auſtralis*, by whoſe combuſtion it is deſtroyed; and this combuſtion is the primary cauſe of the greateſt perturbations of the atmoſphere.

Theſe ideas the writer applies in explanation of many facts in meteorology, by which facts his theory is reciprocally ſupported. The particulars being incapable of abridgment, we muſt refer ſuch of our readers as wiſh to conſider them minutely to the paper itſelf.

Account of ſome Experiments on Wheel Carriages. By Richard Lovel Edgworth, *Eſq.*

I WAS preſent, in 1773, at a ſet of experiments that were tried in London to determine the relative advantage of high and low wheels for carriages.

The load upon a carriage in paſſing over an obſtacle reſiſts the power which draws it, not only by its weight, but by its vis-inertiæ; after a carriage has been once ſet in motion upon a ſmooth road with any giving velocity, its motion, ſo long as that velocity is continued, is neither retarded nor promoted by its vis-inertiæ; but whenever it paſſes over any height, not only the weight of the carriage muſt be lifted up, but the vis-inertiæ of that weight muſt be overcome in a new direction, and as much velocity muſt be communicated to it in that new direction as will enable it to riſe to the height of the obſtacle whilſt it paſſes over its baſe. When an obſtacle is of ſuch a ſize and ſhape that a wheel of ſix feet diameter muſt ſtrike the top of it at once, and not roll from the bottom upwards, and when its ſhape will permit a ſmaller wheel to touch it during its whole aſcent, as there is more time allowed for overcoming the vis-inertiæ of its weight in the latter caſe than in the former, the ſmaller wheel may be drawn forward by a leſs power than the larger, notwithſtanding the advantage of lever, which is in favour of the larger wheel.

To determine theſe circumſtances by experiment, it was neceſſary to conſtruct an apparatus different from that which I have deſcribed. I at firſt made uſe of an inclined plane of five or ſix feet long, and one foot high, placed upon a ſmooth horizontal floor. The diſtance to which the carriage was driven upon the floor by the velocity which it acquired in its deſcent down this inclined plane, I aſſumed as the meaſure of its acquired force, and the reſiſtance of any obſtacle which I placed in its way I determined by the diminution of this diſtance. But though I was well ſatisfied with the accuracy of this mode of trial, I conſtructed another that might appear to others leſs liable to objection.

I ſcrewed a circle of iron three feet three inches diameter upon a ſolid floor; in the center of this circle I erected an upright axis or roller upon two pivots, one reſting in a ſocket of braſs upon the floor, the other in a bridge which was raiſed acroſs the machine. This axis or roller had a ſmall ſilk cord wound round its circumference, which paſſing into an adjoining ſtaircaſe, had a ſcale and weights tied to it, which turned the roller with the required velocity. From the roller a horizontal arm of wood extended to the circumference of this iron circle, and to its extremity was faſtened a piece of ſteel in the form of an axle-tree of a carriage, and upon this was placed a wheel, which by theſe means was carried round upon the braſs circle, as the ſtone of tanners bark-mill moves round the trough which belongs to it. This arm was permitted to move up and down by means of a hinge, ſo as to let the wheel riſe over any obſtacle which was placed in its way. Beſides this another arm was placed above that which carried the wheel, at the extremity of which was faſtened a piece of tin, forming a vane, which, by its reſiſtance to the air, regulated the motion of the machine. The roller was now made to turn by putting weights into the ſcale, and it was let to revolve until its motion became uniform. After eight or ten turns it revolved with an equable velocity; and during every ſet of experiments the ſame velocity was preſerved, and whatever reſiſtance the carriage was expoſed to was overcome by the addition of weight. The additional weight became therefore, in all caſes, the meaſure of the additional reſiſtance, and determined with the greateſt accuracy the reſult of every experiment which I wiſhed to try.

Having found that nearly five pounds and a half was ſufficient to give the wheel, when loaded ſo as to weigh about four pounds, a velocity of nearly ten feet in a ſecond, I placed an obſtacle of a quarter of an inch high upon the plane, and it required no leſs than ſix pounds and a half to overcome its reſiſtance. Two ſuch obſtacles required fourteen pounds and a half. Two obſtacles of the ſame height, but of a different ſhape, each making an inclined plane of three quarters of an inch long and a quarter of an inch high, were ſubſtituted in the place of the former, and it required but two pounds to overcome their reſiſtance. The difference, therefore, between two and fourteen muſt be attributed to vis-inertiæ; for the velocities of the carriage and the heights of the obſtacles remaining the ſame, the only difference that exiſts is, that in the one caſe the wheel has much more time to ſurmount the obſtacle than in the other, and conſequently had much leſs vis-inertiæ to overcome.

From this conſideration it appears that whatever permits the load to riſe gradually over an obſtacle, without obſtructing the velocity of the carriage, will tend to facilitate its draught; and the application of ſprings has this effect to a very conſiderable degree. The ſame weight of four pounds being drawn over the ſame obſtacles, when ſprings were put between the load and the carriage, by four pounds inſtead of fourteen. This remarkable difference points out the great advantage of ſprings in rough roads; an advantage which might be obtained for heavy waggons as well as for other carriages by a judicious application of the ſame means.

It has but ſeldom happened that the modeſty of theory has promiſed leſs than what has been verified by experiment; but it appears from the Memoirs of the French Academy that the idea of applying ſprings to carriages had occurred to Monſieur Thomas in the year 1703, who has given a drawing of a carriage conſtructed upon this principle many years before it was attempted to be put into execution. So little hope had he entertained of ſucceſs, that he expreſsly mentions it as a theory which could not be reduced to practice; he had, however, no notion of applying ſprings to facilitate the draught, but merely for the convenience of the rider; and I apprehend that it is not at preſent commonly imagined that ſprings are advantageous for this purpoſe; nor would it at firſt ſight appear credible, that upon a rough paved road, ſuch as are common in Cheſhire and other parts of England, a pair of horſes could draw a carriage mounted upon ſprings with greater eaſe and expedition than four could draw the ſame carriage, if the ſprings and braces were removed, and the carriage bolted faſt down to the perch. I tried ſome other experiments with the ſame apparatus to compare long and ſhort, high and low carriages. I have loſt the particular reſults of each experiment, but I am well aſſured that the preference which has lately been given in England to high carriages is ill-founded; that upon ſmooth roads the height of the carriage is a matter of indifference as to the draught, and that in rough roads it is conſiderably diſadvantageous; that the length of carriages, if their weight be not encreaſed, is alſo a matter of indifference, except in very uneven roads, and where there are deep ruts; in the former long carriages are preferable, in the latter ſhort ones.

An Enquiry into the different Modes of Demonſtration, by which the Velocity of Spouting Fluids has been inveſtigated a priori. By the Rev. M. Young, *D.D. F.T.C.D. & M.R.I.A.*

THE ancients had no knowledge of the meaſure of the flux of waters. Benedict Caſtelli was the firſt who opened a way to a true meaſure, the reſult of his enquiry is contained in his treatiſe *Della meſura dell' acque correnti*; which meaſure he found to depend on the area of the ſection and the velocity of the water conjointly.

Few writers on this ſubject acquieſce in the ſolution of another. Even Newton has given two demonſtrations not very conſiſtent with each other.

The demonſtration in the firſt edition of his *Principia* he endeavours to prove, that the velocity of the ſpouting water is equal to that which a heavy body would acquire in falling through half the height of the water above the aperture; in his ſecond and third editions he relinquiſhes this calculation, and demonſtrates that the velocity is that which would be acquired in falling through the entire altitude. Yet he immediately ſubjoins an account of experiments which he made with a view to aſcertain this point, and which ſeem inconſiſtent with the demonſtration he adheres to, though very conſonant to that which he rejects.

The demonſtration which he gives in the firſt edition appears at firſt ſight to be unexceptionable, and has accordingly been received by the learned Emerſon, Whiſton, Mr. Wildbore in Hutton's *Miſcellanea Mathem.* and other good philoſophers. It is to this effect:

If a veſſel be filled with water, and perforated in the bottom ſo as that the water may flow through the aperture, it is manifeſt that the bottom will ſuſtain the weight of all the water except the weight of that part perpendicularly incumbent over the orifice. For if the orifice be cloſed by any obſtacle, that obſtacle will ſuſtain the weight of the water perpendicularly incumbent on it, and the bottom of the veſſel will ſuſtain the reſt. But on removing the obſtacle, the bottom of the veſſel will be preſſed in the ſame manner as before, and the weight which was ſuſtained by the obſtacle being now no longer ſupported, will produce an efflux of the water through the orifice. Whence it follows, that the motion of the whole effluent water is ſuch as can be produced by the weight of the column of water incumbent over the orifice. For every particle of water deſcends by its own weight, as far as it is not impeded, with a uniformly accelerated motion, and as far as it is impeded it will preſs the obſtacle; that obſtacle is either the bottom of the veſſel or the inferior deſcending water, and therefore that part of the weight which the bottom of the veſſel does not ſuſtain will preſs the effluent water, and generate a motion proportional to it.

Dr. Young ſays there is a fallacy in this argument, viz. that each plate of water is ſuppoſed to be ſucceſſively diſcharged with a uniform velocity, and the quantity of motion generated in every little portion of time in which each plate is diſcharged is meaſured by the plate drawn into the uniform velocity of the efflux. But this, on a little conſideration, will be found not to be a true ſtatement of the caſe; for every plate of water is diſcharged in time, and its velocity is uniformly encreaſed from nothing, during the deſcent of the plate through its own altitude, at the end of which little portion of time it attains that ultimate velocity with which it afterwards continues to move uniformly. Hence, therefore, it follows that the quantity of motion really generated during the time of the diſcharge of each plate of water is but half that which is determined by ſuppoſing the water to be diſcharged at once with its full velocity. The correction of this error will lead us to a true ſolution of the queſtion. Let the time of a body's fall through the height, be divided into an indefinite number of little portions, each equal to the time in which a plate of water is diſcharged by deſcending through its own altitude. The quantity of motion generated in the cylinder in the time of the fall is equal to the ſum of the quantities of motion generated in that cylinder in all the little portions of time into which the whole time is divided, taken ſeparately; that is, equal to the ſum of the quantities of motion generated by the preſſure of that cylinder, in the ſame little portions of time, in the ſucceſſive plates of water (becauſe equal forces generate equal quantities of motion in the ſame time); that is, equal to half the quantity of motion in theſe plates as meaſured by the ultimate velocity continued uniform for theſe portions of time. Whence it follows, that the quantity of motion generated in the incumbent cylinder, if it were ſuppoſed to fall freely through its height, is equal to half the quantity of motion of the cylinder ſuppoſed to be diſcharged in the ſame time with a uniform velocity.

The mode of demonſtration purſued by Sir Iſaac in his ſecond and third Principia, has been admitted and diſcuſſed at large by Jurin, Maclaurin, Robinſon, and others. But many reaſons conſpire to render ſuſpicious the truth of their reaſoning.

Doctor Helſham's demonſtration of this propoſition is to the following effect: If we ſuppoſe the column of water which ſtands directly over the orifice to be divided into an indefinite number of plates of an equal, but exceedingly ſmall thickneſs, we muſt allow that whatever be the force of gravity wherewith the uppermoſt plate preſſes upon the ſecond, the ſecond preſſes on the third with a double force, and the third upon the fourth with a triple force, and ſo on; ſo that the plate which is next the orifice is preſſed downward by the joint gravities of the ſeveral plates which lie above it, and likewiſe by the force of its own gravity, inaſmuch as there is no other plate beneath it whereon to reſt; conſequently from its own gravity, and that of the ſeveral plates above it, it does all at once receive as many equal impreſſions from gravity, as it would ſucceſſively in falling down the height of the water; and of courſe muſt paſs through the orifice with the ſame velocity that it would acquire in falling down that height.

This demonſtration appears to be defective in this reſpect, that it does not take into account the time in which the force accelerating the diſcharge of the water acts; for it is evident, that the greater the velocity with which the loweſt plate of water is diſcharged through the orifice the ſhorter will be the time during which it is accelerated by the preſſure of the incumbent fluid.

Abbè Winkler's demonſtration is built on the ſame foundation with Helſham's.

Muſſchenbroeck's demonſtration of this principle is liable to a three-fold objection: Firſt, it is founded on a falſe meaſure of the force of bodies in motion, to wit, the quantity of matter and the ſquare of the velocity. Secondly, it involves a confuſion of what is an equal ratio with a ratio of equality. Thirdly, it implies that equal forces generate equal velocities, without any regard to the times in which they act, or the quantities of matter which they move.

Varignon proves only, that the velocities of ſpouting fluids are in the ſubduplicate ratios of the heights of the fluids above the apertures, but does not aſcertain the actual velocity, which is the principal object of enquiry. See Acad. Science. An. 1703.

Belidor's demonſtration is ſubject to the ſecond imperfection of Muſſchenbroeck's. For from proving, after Varignon, that the velocity of the effluent water is proportional to the ſquare root of the height of the water, and therefore follows the ſame law of acceleration with that of falling bodies, he concludes, that the velocity of the ſpouting water is actually the ſame which a heavy body would acquire in falling through the height of the fluid.

Profeſſor Graveſende, who has conſidered this ſubject with particular attention, has alſo given us a demonſtration, that the velocity of the effluent water is equal to that which a body would acquire in falling through the entire height of the fluid. But it appears liable to the following objections: Firſt, it ſuppoſes, that the velocities communicated to equal quantities of matter, in moving through equal ſpaces, are directly as the generating forces, without any regard to the time in which theſe ſpaces are run over by the bodies moved. And ſecondly, it ſuppoſes that the forces acquired by the falling bodies are equal when the heights are inverſely as the maſſes; whereas they are equal only when the maſſes are in the inverſe ſubduplicate of the heights.

I have already ſhewn how the demonſtration given in the firſt edition of the Principia, when duly corrected, affords a legitimate ſolution of this problem; and the ſame concluſion may, I think, be thus otherwiſe made out in an unexceptionable manner.

Let MNOP repreſent a veſſel of water filled to the level GH; MP the bottom, in which is the aperture CD; CIKD the column of water ſtanding directly above the orifice, and CABD the loweſt plate of water immediately contiguous to the aperture. Alſo let v denote the velocity which a heavy body would acquire in falling freely through the height BD of the plate, and x the velocity acquired by the ſame plate during its deſcent through the ſame ſpace until it is diſcharged by the preſſure of the column CIKD. See Plate XVI. Fig. 1.

Suppoſe the loweſt plate of water ACBD to fall as a heavy body through the height BD, its moving force will be its own weight. Again, ſuppoſe it to be accelerated by its own weight and that of the incumbent water, that is, by the weight of the column CIKD through the ſame ſpace, that is, while it is accelerated from quieſcence until it is actually diſcharged. The velocity in the former caſe will be to that in the latter as the moving forces and the times in which they act directly, and the quantities of matter moved inverſely. But the moving forces are to each other as the heights BD and KD; the times in which they act are inverſely as the velocities, the ſpace through which the body is accelerated being given; and the quantities of matter moved are equal; therefore $v : x :: \frac{BD}{v} : \frac{KD}{x}$; conſequently $v^2 : x^2 :: BD : KD$. But v is the velocity which a heavy body would acquire in falling through the ſpace BD; therefore x, the velocity of the ſpouting fluid, is that which a heavy body would acquire in falling through KD, the height of the fluid above the orifice.

In the ſame manner it may be ſhewn, that if a pipe be inſerted horizontally in the veſſel NOMP, the plate of water ACBD will be diſcharged with the ſame velocity as before, whatever be the thickneſs of the plate; this velocity not depending on a continual acceleration through the length of the tube, otherwiſe the effluent water could not attain its full velocity, until a column had been diſcharged whoſe baſe is equal to the orifice and height equal to the length of the tube: whereas we find by experience, that this full velocity can be attained by the thinneſt plate which we can let eſcape from the aperture.

What is here ſaid of the velocity of the effluent water is true only of the middle filament of particles which iſſue through the center of the aperture, and which ſuffer no other retardation than what ariſes from the reſiſtance of the air, and their mutual adheſion and attrition againſt each other. But thoſe which iſſue near the edges of the aperture undergo a greater attrition, and therefore ſuffer a greater retardation. Hence it follows, that the mean velocity of the whole column of effluent water will be conſiderably leſs than according to theory.

Sir Iſaac Newton, who examined every ſubject that came before him with peculiar accuracy, firſt diſcovered a contraction in the vein of effluent water; and he found, that at the diſtance of about a diameter of the orifice, the ſection of the vein contracted nearly in the ſubduplicate ratio of 2 to 1. Hence he concluded that the velocity of the water, after its exit from the aperture, was encreaſed in this proportion, the ſame quantity paſſing in the ſame time through a narrower ſpace. Now, from the quantity of water diſcharged in a given time through that narrow ſection, he found that its velocity there was that which a heavy body would acquire in falling through the height of the water above the orifice; and ſince the velocity there was greater than immediately in the orifice in the ſubduplicate ratio of 2 to 1, he concluded that the velocity of the effluent water in the orifice was equal to that which a heavy body would acquire in falling through half the altitude. But all this is true only of the mean velocity; for there is no cauſe which can actually accelerate the water after its exit from the orifice, whatever cauſes may contribute to its retardation. The manner in which the mean velocity of the water is encreaſed after its diſcharge, though the actual velocity of the ſeveral particles continues unvaried, may be thus explained; the particles which iſſue near the ſides of the orifice proceed converging towards the axis of the vein, and with a retarded motion, upon account of their attrition againſt the ſides of the orifice; and as the central particles move faſter than thoſe which are farther from the axis, each plate of water after leaving the orifice, will aſſume a curved form, the concavity of which will reſpect the orifice.

Let E F be the diameter of the vein where narroweſt, and A B the diameter of the orifice; the line of particles A B, which leave the orifice at the ſame inſtant, will aſſume a curvilineal poſition E G F, the central particles at G moving faſter than the extreme ones at E and F; the particles, therefore, in the diameter of the vein between E and F are ſupplied from the plates of water which iſſued ſucceſſively after E G F; and theſe extreme particles being thus diminiſhed in number, the central particles continuing nearly the ſame, the mean velocity muſt be encreaſed, becauſe that velocity is found by dividing the ſum of the velocities of all the particles by their number, and the number of particles which move with the greateſt velocity bears a greater proportion to the whole number in the narrow ſection of the vein at EF than in the orifice. In ſhort, to expreſs myſelf perhaps more clearly, the particles in the diameter AB, without being accelerated after their exit from the orifice, paſs through a leſs ſpace, becauſe they arrive at that ſpace in different times. It appears, therefore, that the actual velocity of the effluent water is not encreaſed after its diſcharge from the orifice, the contraction of the vein not inferring any ſuch augmentation, and there being no cauſe by which it could be produced. That the velocity with which the water is diſcharged is really ſuch as the theory gives, is ſufficiently confirmed by the well-known experiment that water ſpouts to the level of the reſervoir, except ſo far as it is impeded by external cauſes. But though the velocity with which water, unreſiſted

ſiſted in its paſſage, iſſues through the aperture may be thus aſcertained by the height or diſtance to which it ſpouts, yet the mean velocity of the whole body of effluent water, taking in all cauſes obſtructing its diſcharge which ſeem to lie beyond the reach of calculation, will be conſiderably leſs than this, and can be eſtimated in general by the analogy of experiment only.

The manner of making this eſtimate is to find by experiment the quantity diſcharged, in a given time, in any particular caſe, and reducing it to a column whoſe baſe is equal to the aperture, the height of that column will be the ſpace which would be deſcribed in the propoſed time by all the particles moving with a common velocity. The height of a column diſcharged in any number of ſeconds t is equal to $2\,t\,F\,\sqrt{l\,D}$, F denoting the area of the aperture in ſquare inches, l the ſpace which a body deſcribes in one ſecond, falling freely from a ſtate of reſt, and D the height from which a heavy body muſt fall in order to acquire the velocity of the effluent fluid. A cubic inch of water weighs ,52746 parts of a troy ounce; therefore $\left.\overline{\frac{W}{14{,}65\,t\,F}}\right|^2 = D$, the height from which a body muſt fall to acquire the mean velocity with which the water ſpouts out, W denoting the weight of the water in troy ounces. Thus ſuppoſe a cylinder 20 inches high, kept conſtantly filled with water, is found to diſcharge 20 ounces troy through a circular aperture of $\frac{1}{5}$ of an inch diameter, in 15 ſeconds; by the foregoing formula the height from which a body muſt fall to acquire the velocity with which the water is diſcharged will be 8,35 inches; that is, a ſpace which is to the whole height of the water above the orifice as 10 to 24 nearly. But as it is a difficult matter to keep the fluid always at the ſame height, without encreaſing the preſſure by pouring it in, it may perhaps be conſidered a more exact method to calculate *a priori* the time in which the veſſel ought to diſcharge itſelf, and noting the actual time of the diſcharge by experiment, to diminiſh the velocity of the efflux determined according to theory in the ſame ratio in which the time of the diſcharge has been encreaſed.

Now as the baſe of the veſſel is to the orifice, ſo is the time in which the veſſel would empty itſelf to that in which a body would fall freely through the height of the water in the veſſel: let therefore B denote the baſe of a cylindrical or priſmatic veſſel, in which is an orifice whoſe area is O; the time in which a body falls through A, the altitude of the fluid, is equal to $\sqrt{\frac{A}{l}}$ in ſeconds; therefore $\frac{B}{O} \times \sqrt{\frac{A}{l}}$ is the time required in ſeconds.

Let A the altitude of a veſſel filled with mercury be 9 inches, l 193 inches, the diameter of the cylindrical veſſel 1 inch, and the diameter of the circular aperture $\frac{1}{20}$ of an inch. The time of the diſcharge by theory, according to the foregoing formula, will be 86,4 ſeconds; but by experiment it is found to be 140 ſeconds nearly; therefore the velocity of the efflux by theory is to be diminiſhed in the ratio of 140 to 86,4; that is, in a ratio between the ratios of the ſquare root of 2 and the ſquare root of 3 to 1.

But this method alſo is ſubject to inaccuracy; for the motion of the fluid is found not to be very regular towards the end of the flux; it will therefore be better to calculate the time in which the veſſel ſhould empty itſelf to a certain depth, which is done in the following manner: The times in which the whole and part would be evacuated are reſpectively $\frac{B}{O} \times \sqrt{\frac{A}{l}}$, and $\frac{B}{O} \times \sqrt{\frac{P}{l}}$, P denoting the height of the part. Therefore the difference is $\frac{B}{O\sqrt{l}} \times \overline{\sqrt{A} - \sqrt{P}}$, in ſeconds.

Thus let the altitude of water in a veſſel wholly and in part filled with water be 16 and 12 inches, the diameter of the cylindric veſſel 5,74, and the diameter of the circular aperture ,2. Then, by the foregoing formula, the time in which the water ſhould ſubſide, according to theory, from the height of 16 to 12 inches, would be 33 ſeconds. But the time actually found by experiment is 53 ſeconds; therefore the velocity determined by theory is to be diminiſhed in the ratio of 53 to 33, or 1,6 to 1, *i. e.* very nearly in the ſame ratio as determined by a former experiment, in which the ſpouting fluid was mercury.

Obſervations on Gunpowder. By the Hon. GEORGE NAPIER, *M. R. I. A.*

THESE are deduced from a ſeries of experiments carried on by the writer, at the laboratory at Woolwich. He conſiders—1. The ſelection of the materials which compoſe gunpowder. The purity of the nitre is the firſt thing to be regarded; yet the Ruſſian powder, which is the beſt of all, is made with nitre ſeldom refined more than twice, and which, on being analyſed, appears to contain a conſiderable portion of marine ſalt and magneſia. This extraordinary fact induces the writer to ſuppoſe, that the too frequent depuration of nitre may ſeparate an elaſtic fluid which contributes in great meaſure to the ſtrength of the gunpowder; an opinion confirmed by the facts, that in purifying a large quantity of nitre there is a perceptible loſs of weight beyond what the weight of the reſiduum will account for;---and that not ſo much nitre can be obtained from damaged powder, as from freſh. Mr. Napier prefers that ſalt-petre whoſe cryſtals are of a moderate ſize, ſolid, tranſparently white, which do not readily break with a crackling noiſe when gently graſped in the hand, and which, when ignited on a red hot ſhovel do not decrepitate, but melt and conſume with an equable and continued inflammation. The reaſon of theſe requiſites is to avoid a ſuperabundance of mother-water in the cryſtals, which is replete with foreign ſalt. For the ſame reaſon he adviſes a ſlow cryſtallization, and not promoted by a ſudden refrigeration, as is commonly done. As to charcoal, that ſhould be preferred which contains the greateſt quantity of alkaline ſalt. The purity of the ſulphur is of great importance, and every manufacturer ſhould purify it for himſelf.

2. The proportion of the ingredients. This depends ſo much on the quality of the materials, that particular trials for each new parcel as recommended by the French are more to be depended upon than any fixed rules. The moſt approved proportions are, Nitre 3lb. Charcoal 8½ to 9½ oz. Sulphur 2¾ to 3¼ oz.

3. The mode of mixing and incorporating the ingredients. This is a matter of great importance, and yet much neglected. The former method, and which is ſtill practiſed in ſome places, was by ſtamping-mills, conſiſting of mortars in which heavy wooden peſtles were moved by the force of water or horſes. The danger of exploſion from this mode of operation has cauſed it to be laid aſide in the ordnance powder-mills in this country, and in its ſtead, this part of the proceſs is performed by ſtone cylinders rolling vertically round a circular trough. That this does not perform the buſineſs ſo effectually, is apparent from the diminution of the ſtrength and durability of powder ſince it was employed; and it has obviouſly this radical defect, that the powder in the operation becomes compreſſed into a hard cake, over which the ſtones roll with very little derangement of the ſurface. Moreover, from economical motives,

the time allotted to the proceſs of mixing has been much ſhortened. Mr. Napier propoſes as an improvement in milling, that the rollers ſhould be made of caſt iron, as well as the trough in which they move, and that the periphery of the cylinder ſhould be divided into eight parts, half plain, and half grooved: the grooves in two of the diviſions to run longitudinally, and in two tranſverſly. With reſpect to the drying of powder, the means at preſent in uſe fail of doing it equably.

The writer next proceeds to ſome general obſervations ſelected from thoſe which occurred in the courſe of his experiments. On ſeparating the duſt from the grain of powder, returned as unſerviceable, it was found that the former almoſt always turned out ſtronger on the proof than the latter. This was accounted for by diſcovering with a magnifying glaſs that the grains had thrown to their ſurface little ſpiculæ of newly cryſtalliſed nitre, which being broken off by attrition formed the duſt. New powder when reduced to duſt does not loſe ſtrength, but rather gains; which ſuggeſts a doubt, whether the large-corned powder now manufactured is ſuperior to the ſmall-grained formerly made. Mr. Napier diſcovered in 1782 in the magazines of Purfleet, ſome barrels of very ſmall-grained powder made in the reign of Charles II. which was in complete preſervation. At that time moſt of the nitre uſed in England was produced at home.

The proceſs of glazing powder reduces its ſtrength $\frac{1}{5}$th or $\frac{1}{4}$th, but it is rendered thereby more durable, and therefore is proper in all high-proof powder ſent to the magazines at a diſtance. Powder would be better preſerved from the action of the atmoſphere by lining the barrels with thin lead, or by expoſing it to a free circulation of dry air. Frequently reverſing the barrels tends to prevent the decompoſition which ariſes from the different gravity of its ingredients. The kind of powder in general to be preferred from its external appearance, is that of a moderate-ſized and ſomewhat ſpherical grain, and of a greyiſh blue colour, tinged with red. The ſtrength of powder is often impaired by being too precipitately dried, in which caſe part of the ſulphur is evaporated, and the grain is left moiſt at the center. Such powder, though riſing to high proof when freſh dried, will be lowered in ſtrength at leaſt one-fourth after being a month in the magazine. Great errors have been committed by overloading pieces with powder, which not only waſted the powder, but augmented the reſiſtance. This has been corrected, but he thinks it would ſtill bear a reduction. Salt of Tartar would increaſe the report of powder, but diminiſh its ſtrength. It might be economically employed in making powder for ſalutes and purpoſes of parade.

Obſervations on the Magnetic Fluid. By Capt. O'BRIEN DRURY, *of the Royal Navy.*

THE ſubject of this very ſhort paper is an experimental obſervation, that by caſing the needle of a compaſs with thin poliſhed ſoft iron, or arming it with the ſame at its poles, it preſerves its magnetiſm much more perfectly than without thoſe precautions.

A critical and anatomical Examination of the Parts immediately intereſted in the Operation for a Cataract; with an Attempt to render the Operation itſelf, whether by Depreſſion or Extraction, more certain and ſucceſsful. *By* SYLVESTER O'HALLORAN, *Eſq. M. R. I. A. &c.*

AFTER the writer has mentioned ſome of the principal points of former anatomical deſcriptions of the iris and cryſtalline lens, in which he particularly notes the errors of repreſenting the iris as flat, and as affording a poſterior chamber to the aqueous humour by its diſtance from the vitreous, he gives the following as an exact deſcription of theſe parts.

"The vitreous humour occupies all the poſterior and anterior part of the eye as far as the iris, leaving a ſmall ſocket or cavity in its anterior part for the lodgment of the cryſtalline lens. It is ſaid to be covered by a fine membrane, called tunica vitrea; but for my own part, who have diſſected as many eyes, and of different animals, as I believe any man, I confeſs I have never been able to trace any membrane ſurrounding it, except in its anterior part, *and there it is covered very ſenſibly and very remarkably.* Leaving then the deſcription of this tunica vitrea to thoſe that can find it, I ſhall obſerve that when the vitreous humour reaches the iris, there is a cloſe adheſion between them by the intervention of a firm pellucid membrane ariſing from the inſide of the choroides, exactly oppoſite to that part where the adherence between this laſt and the ſclerotica commences, called ligamentum ciliare. This membrane covers all the anterior part of the vitreous humour; but when it reaches the ſocket or cavity in which the cryſtalline is contained it ſeparates; the poſterior, and by much the finer part, lines this ſocket, whilſt its anterior one covers the cryſtalline, ſo that it becomes encloſed in it as a nut is in its ſhell. Thus the cryſtalline is encloſed in a fine pellucid membrane, which capſula is conſtantly humected with a tranſparent liquor, which prevents any kind of adheſion or connection between it and this interpoſed body. The anterior part of this capſula is ſo denſe as to be ſometimes capable of being ſeparated into two diſtinct coats; the contained liquor is, from its diſcoverer, called Morgagni's liquor.

"I have ſaid, contrary to all anatomiſts, that the inſide of the iris adheres cloſely to the anterior part of the vitreous humour, except where it opens for the lodgment of the cryſtalline; and the better to comprehend this fact, I ſhall give a new deſcription of the iris. With other anatomiſts, I always imagined that this laſt was a real continuation of the choroides; I am now ſatisfied that it is not, and that the aſſertion is very nearly as abſurd as to affirm that the diaphragm is a continuation of the pleura, though the choroides adheres pretty cloſely to the ſcletorica, near the inſertion of the optic nerve; yet from thence to the ligamentum ciliare, the correſpondence is moſtly kept up by blood-veſſels and nerves paſſing from one to the other. Here a cloſe adheſion of the choroides to the ſcletorica commences. At the middle of the ſuperior and inferior part of the eye, it begins at the very edge of the ſclerotica, bordering on the cornea tranſparens, but from thence to the two canthuſes it gradually retires back on the ſclerotica; the adhering part from the choroides, called ligamentum ciliare, is truly tendinous, and forms an expanſion or covering to the iris; withinſide this are groupes of blood-veſſels from the arterial circle of the iris, proceeding in nearly ſtraight lines, as well to the pupilla as to the ciliary ligament. To prove that the iris is totally different from the choroides and truly muſcular, it is only neceſſary to obſerve, that the inſide of the ligamentum ciliare anſwering to its breadth, is fleſhy and thicker than any other part of this body; its fibres proceed radiated or nearly ſo from thence towards the iris. Here the covering of the anterior part of the vitreous membrane commences, and ſo cloſely is this attached to theſe radiated fibres, that their impreſſions are ſunk deep into it, and may be called the ſulci of the proceſſus ciliares. This firſt range of fibres on the inſide of the iris is in a human eye about the breadth of a line; a kind of tendinous narrow and circular band cloſes this phalanx, and from thence proceeds a ſecond row of radiated fibres thinner than the firſt; theſe alſo adhere and leave their impreſſions on the vitreous membrane; and that part of the iris which forms the pupilla is ſtill finer than the laſt-mentioned, reſts on the cryſtalline, and is quite free from any adherence, by which means it contracts or dilates in proportion to the vicinity or diſtance of objects. Thus the convexity of the iris follows nearly that of the cornea tranſparens, and is occaſioned by the protuberance of the cryſtalline; ſo that the idea of a poſterior chamber of the aqueous humour muſt be for ever baniſhed; nor is that of circular fibres belonging to the iris better founded in truth and anatomy. Theſe laſt we are conſtantly told were formed for the purpoſe of contracting, as the radial ones were for expanding, the pupilla; but not to advert to a fact, which is, that the ſtate of quieſcence in the pupilla is its dilatibility, which is evident, becauſe when aſleep or in a ſtate of inattention with reſpect to objects, we conſtantly find it ſo; I ſhall juſt obſerve, that there are none but radial fibres through the whole internal ſurface of the iris. That the convexity of the iris may be proved beyond a poſſibility of doubt, let the ſide of the cornea be pierced at its junction with the ſclerotica by a lancet or cataract needle, and paſſed in that direction to the oppoſite ſide of the eye. On examination you will find, that beſides the cornea you will have wounded the iris a line higher than the ligamentum ciliare. If you perforate another eye a line and an half higher up on the cornea, it will juſt glide over the pupilla, and from this to the top of the cornea within is another line. If from the ſummit of the cornea a ſtraight line be drawn, and parallel to one from the riſe of the iris, *i. e.* the ligamentum ciliare at the ſides of the eye, the diſtance will be found to be three lines and an half. Thus the diſtance between the riſe of the iris and the pupilla or its upper extremity, is generally two lines and an half, oftener more, meaſured from either canthus; but from the middle of the ſuperior and inferior parts of the eye, as it lies in the orbit, a line leſs."

Mr. O'Halloran then proceeds to explode the common idea of adherent cataracts, ſhewing that it is the capſule of the cryſtalline lens alone which has an adheſion to the ſurrounding parts, and by no means the lens itſelf, whether ſound or diſeaſed. On this he founds an improvement on the operation of couching, which conſiſts in uſing a broader needle, and with a cutting edge, whereby the capſula may be freely opened, and the cataract diſlodged from it. For this purpoſe, he gives particular directions in operating.

With reſpect to the operation of extraction, he repreſents it as very unſucceſsful in its uſual method of performing, which he thinks certain to produce much opacity in the cornea, and to wound the iris and diſcharge part of the vitreous humour. He propoſes a new mode of operating, with a knife ſomewhat convex, in order to paſs over the *convex* (not flat) ſurface of the iris; and he carries the inciſion upon the ſclerotica, not the cornea. It does not appear that this mode has been actually put in practice.

An

An Account of Experiments made to determine the Temperature of the Earth's Surface in the Kingdom of Ireland in the Year 1788. *By the Rev.* WILLIAM HAMILTON, *F.T.C.D. and M.R.I.A.*

THAT the ſources of heat and cold in a particular climate are variable, is evident from a compariſon of the different temperature of different years, no two of which perfectly agree in this point. But what is the effect of this variation on the general temperature of a country, whether this be an increaſing, decreaſing or permanent quantity, is a curious problem, which it is the purpoſe of this paper to reſolve, by the reſults of an experimental enquiry. The principles on which it is conducted are the following. The ſurface of the earth being ſubject to rapid diurnal variations of heat, can afford no proper ſtandard of compariſon; but at the depth of 30, 40, or 50 feet, a ſlow and gradual change of temperature takes place, which is not ſenſible except after intervals of many days. At ſuch depths the earth is found to have attained its greateſt degree of cold about one month after the vernal equinox; and of heat, about a month after the autumnal equinox. Here, then, an opportunity is given of comparing the *months* of different years with each other as to mean temperature. But at the depth of 80 feet, even the monthly changes are not obſerved to be perceptible, and the *annual* ones only are to be diſcovered. As to the beſt *places* in which to carry on experimental obſervations on the temperature; mines, which might be firſt thought of, are improper on account of the accidental alterations of heat to which they are liable from chemical decompoſitions; and covered wells of pure water are to be preferred. The obſervations which have been actually made on this ſubject, are contained in three tables which we here copy.

TABLE I.

Mean Temperature of the Sea-Coaſt of Ireland, obſerved in different Latitudes.

Lat. 55° 12′	Medium temperature of the northern coaſt of Ireland, near the town of Ballycaſtle, obſerved in the year 1788, by means of copious ſprings flowing from a limeſtone ſoil - - -	48,
Lat. 54° 48′	Medium temperature of the iſland of Eniſcoo, one of the Roſſes iſlands, on the weſtern coaſt of Ireland, obſerved by means of a covered well in a granite rock; the maximum of temperature taken in 1787, the minimum in 1788 - - - -	48,6
Lat. 53° 20′	Medium temperature of the eaſtern coaſt of Ireland, near Dublin, obſerved by means of deep covered wells in ſoils of clay, gravel, and limeſtone, 1788 - - - - - -	49,4
Lat. 51° 54′	Medium temperature of the ſouth coaſt of Ireland, near the city of Cork, obſerved by means of deep covered wells in limeſtone and other ſoils, 1788 - - - - - -	51,2

TABLE II.

Mean Temperatures of Places diſtant from the Sea, and elevated above its Surface.

Lat. 55°	Medium temperature in the neighbourhood of Londonderry, diſtant twenty Iriſh* miles from the northern ſea, and at a ſuppoſed elevation of one hundred feet above it (1788) - - -	46,9

Lat.

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[*] 54½ Iriſh miles are almoſt equal to a degree of the meridian, that is, to 60 geographical miles, or to 69½ Engliſh miles.

Lat. 54° 20′	Medium temperature in the neighbourhood of Armagh, diſtant twenty-five miles from the Iriſh channel, and elevated about fifty-eight feet above the coaſt, by means of a well ſixty feet deep ſunk to the bottom of a gravelly hill, (1788) - - - -	47,5
Lat. 53° 12′	Medium temperature derived from the maximum of 1787, and minimum of 1788, in the neighbourhood of Tullamore (in the King's county), near the center of the kingdom, diſtant fifty miles from both the ſeas, elevated two hundred and ſix feet above the coaſt, in a level country, which may be counted the higheſt ground of the general ſurface of Ireland - - - -	48,

TABLE III.

Mean Temperature in Cities.

Medium temperature in different parts of the city of Londonderry by maximum of 1787, and minimum of 1788, various from	47, 6 to 49
Medium temperature in different parts of the city of Dublin in 1788	50 to 52
Medium temperature in different parts of the city of Cork in the year 1788 - - - - - - -	52, 5 to 53, 5

Obſervations on Coal-Mines. By RICHARD KIRWAN, *Eſq. M.R.I.A. and F.R.S.*

THE purpoſe of this paper is to ſerve as a guide to the Iriſh in their reſearches after coal-mines in their country. It commences with ſome general obſervations reſpecting the conſtruction of mountains and hills, in which the diſtinction is adopted, of the primæval granitic maſſes, and the ſecondary ſtratified hills of the argillaceous or calcareous kind. It is in theſe latter alone, or in plains of ſimilar materials, that coal is found. The thicker beds of coal generally lie pretty deep, from 25 to 40 fathoms, or more. They are detected by the borer, by which inſtrument their direction and inclination are alſo to be found. In order to convey a fuller idea of the ſtrata that generally accompany coal-mines, the writer has collected from various authorities, liſts of them and their reſpective thickneſſes in different countries, with which he concludes his paper.

Obſervations on the Properties commonly attributed by Medical Writers to Human Milk, on the Changes it undergoes in Digeſtion, and the Diſeaſes ſuppoſed to originate from this Source in Infancy. By JOSEPH CLARKE, *M.D. M.R.I.A.*

MEDICAL writers have almoſt univerſally agreed in theſe poſitions—that human milk is coagulable in the ſtomach of infants and by various fluids; that it is very prone to run into an aceſcent or acid ſtate; and that from theſe qualities of the milk the greater part of infantile diſeaſes ariſes. Theſe poſitions Dr. Clarke undertook to examine experimentally. As to the coagulability of milk, he found, as others had done before him, that neither runnet, acids of different kinds, ardent ſpirits, nor infuſion of the ſtomachs of infants, in any temperature, would produce any thing like curd from human milk. As the only proof, therefore, of the exiſtence of coagulable matter in it is the appearance of the matter vomited by infants, he is led to attribute this appearance rather to viſcid cream floating on the ſtomach and unaſſimilated by the digeſtive powers. As to the ſpontaneous aceſcency of human milk, he found it to be greatly inferior in degree to that of cows, the latter becoming ſourer in 36 hours, than the former in as many days. Human milk likewiſe equally exceeds cows milk in its diſpoſition to reſiſt the putrid fermentation. Among the ſigns denoting acidity, has been reckoned the green colour of the fæces, it having been ſuppoſed that all acids mixed with bile, produced that colour. But it has been found by experiment, that the mineral acids alone have this effect, and that the vegetable change the bile to yellow. With reſpect to the multiplicity of infantile diſeaſes ſuppoſed to originate from acidity, Dr. Clarke obſerves that the young of all ruminant animals are fed with much more aceſcent milk, that many nations uſe ſour curdled milk as their daily food without injury, and that regiſters of mortality in different places ſhow ſo great a difference in the life of infants as renders ſo univerſal a cauſe of their diſeaſes highly improbable. In ſuch a caſe, too, abſorbents would prove a more certain cure for infantile diſeaſes than we find them to be.

Eclipſe of the Sun, obſerved June the 3d, 1788, *by the Rev. Dr. Uſsher and others. Communicated by* HENRY USSHER, *D.D. F.R.S. and M.R.I.A.*

	Mean time. H.	′	″
BEGINNING, by Dr. Uſher	19	3	42,7
The moon touches penumbra of the firſt ſpot at	19	13	21,6
touches nucleus of ditto	19	15	25,3
biſects ditto	19	17	37,0
laſt ſmall ſpot covered	19	20	43,3
Small ſharp protuberance on the moon's limb off the diſk	20	23	28,4
End, by Dr. Uſher	20	25	38,8
by the Rev. William Hamilton	20	25	37,8
by my ſon	20	25	39,8

I obſerved this eclipſe with a parallatic teleſcope of ſeventeen inches focus, having a triple object-glaſs; magnifying power about 75.

Mr. Hamilton obſerved the end with a teleſcope of thirty inches focus double object-glaſs, magnifying power about 120.

My ſon obſerved it by projection on paper, with the teleſcope of a ſmall equatorial of about ſeven inches focus.

Not being yet furniſhed with a micrometer for meaſuring the diſtances of the cuſps, I obſerved the appulſes to the ſpots, propoſing to determine their places by the equatorial; but clouds coming on immediately after the eclipſe, I was diſappointed, and ſhould be extremely obliged to any perſon that may have ſettled them on that day for a communication.

Both Mr. Hamilton and I obſerved a diſtortion and diſcoloration of the ſpots as the moon's limb approached them; and this effect took place at ſuch a diſtance, that I think it cannot be attributed to the inflection of the rays of light, but ſeems more like the operation of the lunar atmoſphere.

Mr. Sutton obſerved this eclipſe at his obſervatory at Drumcondra-hill in Lat. 53. 22. 45.

Beginning - - - -	19. 6. 20. App. time.
End - - - - -	20. 27. 40.

An Account of an Aurora Borealis ſeen in full Sunſhine. By the Rev. HENRY USSHER, *D.D. F.R.S. and M.R.I.A.*

THE following phænomenon being very uncommon, if not entirely new, I think it worth communicating to the Academy, principally with a view to learn whether any other perſon has obſerved a ſimilar one at any time.

On Saturday night, May 24, 1788, there was a very bright aurora borealis, the coruſcating rays of which united, as uſual, in the pole of the dipping needle. I have always obſerved that an aurora borealis renders the ſtars remarkably unſteady in the teleſcope. The next morning, about eleven, finding the ſtars flutter much, I examined the ſtate of the ſky, and ſaw whitiſh rays aſcending from every part of the horizon, all tending to the pole of the dipping needle, where at their union they formed a ſmall thin and white canopy, ſimilar to the luminous one exhibited by an aurora in the night. Theſe rays coruſcated or ſhivered from the horizon to their point of union.

Theſe effects were diſtinctly ſeen by three different people, and their point of union marked ſeparately by each of them.

There is certainly no reaſon for confining the effects of aurora borealis to the night, although it then makes its moſt magnificent diſplay, contraſted by the darkneſs of the ſky.

The tremulous motion of the ſtars at certain times in ſerene ſkies has been taken notice of by the Abbe De La Caille at the Cape of Good Hope; and M. De La Lande remarks that ſometimes, when a ſouth-weſt wind prevails at Paris, the ſame effect is produced. An aurora borealis in this country is generally ſucceeded by a ſouth-weſt wind, and frequently the wind veers round to that point during its appearance; now if this phænomenon, as ſuggeſted by an ingenious member of this Academy, ſhould be inflammable air in a ſtate of inflammation, the water ſo produced by ſuch inflammation might ſatisfactorily account for this unſteadineſs of the rays, whether we ſuppoſe it either in the act of abſorption, or in the ſtate of veſicular vapour deſcending from the upper regions of the atmoſphere.

That inflammable air, at leaſt ſome ſpecies of it, contains iron, cannot well be diſputed, as its effect on an infuſion or tincture of galls ſhews the preſence of iron. That there is ſome connection, hitherto unexplored, between magnetiſm and the aurora borealis ſeems highly probable. The unſteadineſs of the magnetic needle during the appearance of this phænomenon is known to every one, and indicates ſuch connection; the union of the radii of a ſtrong aurora borealis in the pole of the dipping needle ſtrengthens the ſame conjecture, which is ſtill further confirmed by the ſituation of the luminous northern arch, generally the firſt ſymptom of a ſtrong aurora, and from whence, in all probability, the name was taken; for the higheſt point of this arch is always found in the magnetic meridian.

This phænomenon is certainly more common now than it was a century or even half a century ago; this I find moſt people, even the moſt illiterate, agreed in. Upon examining the accounts of the authenticated appearances of the aurora borealis, ſo carefully collected by the celebrated De Mairan, I perceive a chaſm in the liſt of obſervations for about forty years in the laſt century, in the middle of which chaſm, nearly, is the year 1661, in which year we are told the variation of the needle at Paris was 0. We ſeem alſo to collect from the ſame author's reſearches, that the frequency of this appearance ſeems to have decreaſed with the diminution of the eaſtern variation, and it now ſeems to encreaſe with the encreaſing weſtern variation. What real connection there may be between the variation of the needle and the aurora borealis, or the cauſe of it, I acknowledge myſelf entirely ignorant; but perhaps this trifling hint may engage the attention of others who have both more leiſure and abilities for ſuch an intereſting diſquiſition.

POLITE LITERATURE,

An Examination of an Eſſay on the Dramatic Character of Sir John Falſtaff. By the Rev. RICHARD STACK, *D.D. F.T.C.D. and M.R.I.A.*

THE Eſſay to which this paper is a reply, was an attempt to prove that Shakeſpear did not intend to repreſent Falſtaff as a coward. So very paradoxical an opinion is refuted by the arguments which Dr. Stack derives from a fair conſideration of the actions and manners which the poet has attributed to this perſonage.

Obſervations on the Firſt Act of Shakeſpear's Tempeſt. By an Under-graduate in the Univerſity of Dublin.

THE tendency of theſe obſervations is to ſhow the art with which Shakeſpear in the commencement of this drama has diſplayed the characters of the perſons, intereſted us in their fate, and prepared our minds for the wonders attending the ſupernatural agency on which the cataſtrophe turns.

Thoughts on ſome particular Paſſages in the Agamemnon of Æſchylus. By FRANCIS HARDY, *Eſq. M.R.I.A.*

IN the Iliad of Homer not a ſingle circumſtance appears that would lead us to ſuppoſe the language of Troy to have been different from that of Greece; whence it has been commonly concluded, that no difference of this kind really ſubſiſted. But in the Agamemnon of Æſchylus, when the captive Caſſandra is led before Clytemneſtra, and remains ſilent, the Queen, becoming impatient, tells her, if ſhe does not underſtand their language, to make ſigns with her hands. And the chorus, interfering, obſerve that ſhe comes from a foreign city, and ſtands in need of an interpreter. After the departure of Clytemneſtra, Caſſandra breaks out into a wild ſtrain of prophecy; upon which the chorus expreſs their ſurpriſe that a foreigner

ſhould

ſhould ſpeak the Greek tongue as fluently as if ſhe had been educated at Argos. Again, when, after ſhe has continued her prophecies, the chorus confeſs themſelves utterly unable to comprehend them, "yet (cries Caſſandra) you allow that I ſpeak "your language perfectly". Theſe paſſages clearly indicate an implied difference between the language of the Greeks and Trojans.

The writer of this paper is perſuaded that it was not without deſign that Æſchylus introduced this circumſtance; and that he felt it to be agreeable to popular opinion, and therefore neceſſary to the hiſtorical perfection of his drama. This he deduces from the general character of the poetry of Æſchylus, which is diſtinguiſhed for an adherence to nature and real manners, and from the improbability, that before an Athenian audience, he ſhould have ventured upon a deviation from commonly received opinions, which they were all probably qualified to judge of. There was a tradition, it is true, that the Trojans were a Greek colony, and the authority for it is ſtated by Dionyſius of Halicarnaſſus, but it may be regarded as a poetic fable. The ſilence of Homer amounts to no proof, ſince he himſelf, (if the author of the Hymn to Venus) repreſents the Trojans and Phrygians as ſpeaking different languages, a fact not to be deduced from his Iliad. On the whole, this writer thinks that the authority of Æſchylus in this matter is of no ſmall weight, and not eaſy to be got over.

Eſſay on Ridicule, Wit and Humour. By William Preston, *Eſq. M.R.I.A.*

IN Part I. of this Eſſay the writer lays down his general ideas on Ridicule. *Ridicule* is that branch of the fine or mimetic arts which profeſſes to excite the emotion of *mirth.* This it does by a diſplay of the *ridiculous*; that is, an exhibition of defect, and blemiſhes of the lighter kind. The ſenſation called *mirth* has by ſome writers been improperly confounded with *laughter*, which is a mere corporeal affection. In order to explain mirth, or the cauſe of that pleaſure we derive from ridicule, Mr. Preſton has recourſe to the theory of Hobbes; viz. that it proceeds from a ſudden conception of ſome eminency in ourſelves, by compariſon with our own infirmity formerly, or that of others. This notion he thinks confirmed by experience, which ſeems to ſhow, that perſons laughed at are univerſally in ſome degree objects of contempt and degradation. Perſonal infirmities do not of themſelves excite mirth, but when joined with ſomething incongruous in action. And when mirth is produced by the mimetic repreſentation of things which if really exiſting would raiſe other emotions, it is by means of exaggeration and diſtortion. Of the infirmities of the mind thoſe only excite mirth which are of a mild and moderated kind, allowing the ſenſation of triumph by compariſon, without the ſtrong emotions of indignation or horror.

Part I. begins with an attempt to inveſtigate the phyſical cauſe of laughter. Adopting Mr. Burke's notion, in his *Eſſay on the Sublime and Beautiful*, that a degree of relaxation is the cauſe of pleaſure, this writer conceives that the ſlight affection of the mind in mirth, amounting to no more than a mild irritation accompanied with relaxation, operates to the production of laughter. Laughter, he thinks, expreſſes but a pleaſure of a faint and ſubordinate kind, as appears in the ready laughter of young children at every object of delight, however trivial.

He then traces out the ſources of the ridiculous, which he ſuppoſes may all be reduced to the following claſſes. 1. Thoſe actions and geſtures of the brute creation which imitate the human. 2. Slight corporeal blemiſhes and defects. 3. Unforeſeen diſaſters or miſchances of no ſerious kind. 4. Incongruity or inconſiſtency in men's words and actions, which is diviſible into ſeveral ſpecies. On conſidering the the aſſertion that ridicule is the teſt of truth, he denies that it is ſo, becauſe it is the repreſentation of a picture, and therefore cannot be a criterion of what it only repreſents—becauſe it is the repreſentation of a ſingle poſitive picture only, without that collation of two objects which is eſſential to the exiſtence of truth or falſehood—becauſe the perception of ridicule is inſtantaneous, whereas that of truth or falſehood is a progreſſive operation of the mind.

ANTIQUITIES.

An Account of three Metal Trumpets found in the County of Limerick, in the Year 1787.

By RALPH OUSLEY, ESQ. *M.R.I.A.*

THESE trumpets are made of a mixed coppery metal, are curved like a cow's horn, and their chords meaſure $9\frac{3}{4}$ inches, 12 inches, and $15\frac{6}{10}$ inches. Two of them were found connected together by a middle ſtraight tube, $23\frac{6}{10}$ inches in length, one end of which was faſtened on by pins to each. This middle piece is ſuppoſed by the writer to be an unique.

A Martial Ode, ſung at the Battle of Cnucha by Fergus, Son of Finn, and addreſſed to Goll, the Son of Morna; with a literal Tranſlation and Notes. By SILVESTER O'HALLORAN, *Eſq. M.R.I.A.*

"GOLL, the hero of the following rhapſody, was ſaid to be of the blood royal of the Danaan princes, who ruled over Ireland for near two centuries before the arrival of the Clana-Mile, commonly called Mileſians. He ſucceeded his father as hereditary grand maſter of the knights of Connaught. Theſe had been called the Heroes of Irrus, from the ſeat of their principal academy or college in the county of Mayo; but ſo great was the glory and renown acquired by Morna, that from him they were called, The Followers of Morna; by which name they are known, and by no other, at this day. Goll having finiſhed his academic exerciſes, and taken the laſt and ſolemn vows of chivalry, proved himſelf, by a variety of exploits, worthy that place which his rank and blood entitled him to fill. Accordingly, ſoon after the death of his father, we find him called to the chief command of the Imperial army by the monarch Con, ſurnamed Of the hundred Battles, to ſuppreſs a moſt powerful and dangerous confederacy formed againſt him. In the engagement that enſued, called the battle of Cnucha (fought A. D. 155), the enemy were not only completely defeated, but Goll had the additional glory of killing, in ſingle combat, Cumhal, maſter of the Leinſter knights, commander of the enemy's army, and a champion highly celebrated for his valorous deeds both in Britain and Gaul. It was on marching to the onſet, it was in the heat of the fight, and until fortune declared in favour of the imperialiſts in this battle, that this ode was ſung, by Fergus,* the chief bard of Goll. The conſequences of this battle were well remembered above a century after; where Oiſin, in his hunting ode, deplores the death of Cumhal, "ſlain by Mac Morna, of the Golden Shield." The preſent Ode, or rather Rhapſody, I flatter myſelf will appear no unacceptable preſent to the Academy, as well for its originality, as for the lights it throws on ſome obſcure paſſages in the ancients. But to me it ſeems of ſtill greater moment, by (I apprehend) proving "ad inſtantiam crucis," as is ſometimes expreſſed by philoſophers, the early ſtate of arts, letters, and civilization in this country."

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* This Fergus is not to be confounded with Fergus, ſon of Fion Mac Cumhal; for Fion was but a boy at the time of the battle of Cnucha. The author of this ode was a Connaught bard, and celebrated for the harmony of his numbers.

No account is given of the place where the original copy of this ode is depoſited, or the proofs of its antiquity. It is here printed in the Iriſh language and character on one ſide, and the tranſlation on the other. Each line conſiſts of two clauſes, each of which contains ſome epithet or attribute of the hero; as in the following ſpecimen.

Goll, of martial pride. Strong in body, great in arms.
Courteous and polite to the legions. Fierce and powerful in action.
Shield of great luſtre. Flower of unfading beauty.
Rapid as the mountain flood is the force of your ſtrong arm.

A ſea over rivulets. Sullen in the duel.
Great in the uproar of battle. Tower of ſtrong defence.
Billow over ſwelling ſeas. Goll, terrible in the ſhouts.
Lover of conſtant deſolation. Son to the great Morna.

Memoir of the Language, Manners, and Cuſtoms, of an Anglo-Saxon Colony ſettled in the Baronies of Forth and Bargie, in the County of Wexford, Ireland, in 1167, 1168, *and* 1169. *By* CHARLES VALLANCEY, *LL.D. &c. &c.*

IN 1167, Dermod, king of Leinſter, on account of the oppreſſion he exerciſed over his ſubjects, cauſed a total defection from him, and was forſaken by his kinſmen, friends, and followers. He repaired the next year to England, to ſolicit the aſſiſtance of Henry II. from whom he obtained a promiſe of aid; but after waiting ſome time without hearing further from the king, he applied to Richard Earl of Strigul, commonly called Strongbow, offering his daughter in marriage, with his kingdom for her portion, ſhould he recover it by the Earl's means. The Earl excuſed himſelf, unleſs he ſhould obtain king Henry's conſent. In the mean time Dermod applied to the princes of Wales, and Richard Fitz-Godobert accompanied him, but with ſo ſmall a body of men, that they were of no uſe, and they ſoon returned home.

Dermod finding his ſubjects ſtill held out againſt him, cauſed proclamation to be made in Wales, offering large recompenſe in lands, money, and cattle, to ſuch as would give him aid. Immediately men of all ſorts, and from divers places, prepared themſelves to embark for Ireland, under the command of Fitz-Stephen, who had lately been enlarged from priſon by the mediation of Dermod with Rice, a king in Wales. This little army conſiſted of about three hundred horſemen and foot.

With this ſmall body Dermod did wonders, and being grown proud with victory, gave great diſcontent to the Engliſh, many of whom returned home. But in the year following (1169) Earl Richard ſent Raymond Le Groſs to Dermod's aſſiſtance, with a ſmall ſuite, promiſing to follow with a conſiderable army. Accordingly, in 1170, the Earl arrived in Waterford with ſixteen hundred ſoldiers.

This conſiderable reinforcement enabled Dermod not only to ſuppreſs his rebellious ſubjects, but alſo to make war on the neighbouring princes. Peace being once reſtored, Dermod made good his promiſes, and the part of the country we are now deſcribing was parcelled out to the Britiſh ſoldiers, who have remained in quiet poſſeſſion of their atchievements unto this day.

This colony have preſerved their ancient manners, cuſtoms, and language; and fully occupying every inch of ground, the natives could never obtain a re-eſtabliſhment therein. As population encreaſed, ſome of the Engliſh have been obliged to remove into the neighbouring baronies within theſe fifty years, and by an intercourſe with the Iriſh, the language of theſe emigrants became corrupted, and theſe, by their connection with their kindred remaining in the baronies of Bargie and Forth, have in ſome meaſure introduced this corrupted dialect there. The town of Wexford is the market to which this colony reſorted to diſpoſe of the produce of their farms, and in this market all things are bought and ſold in the modern Engliſh dialect; this alſo is another cauſe of the decline of the language of the coloniſts, but not one word of Iriſh is underſtood or ſpoken in theſe two baronies; ſtill they preſerve many words and phraſes of their original language, and ſome original ſongs, which having been committed to writing, will exiſt as long as the people.

When we were firſt acquainted with this colony, a few of both ſexes wore the ancient dreſs: that of the man was a ſhort coat, waiſtcoat, and trunk breeches, with a round hat and narrow brim; that of the woman was a ſhort jacket, a petticoat bordered at bottom with one, two, or three rows of ribband or tape of a different colour. We have ſeen one, whoſe jacket was of ſuperfine woollen cloth, of a dark brown colour, edged with a narrow ſilver lace. The dreſs of the head was a kircher.

The names of the old coloniſts are Hore, Cod, Stafford, Whitty, Roſſiter, Sinnot, Murphy, Stephen, Quiney, &c. The gentlemen who now inhabit the country are moſtly deſcended from the officers and ſoldiers of Cromwell's and King William's army, viz. Hervey, Nun, Edwards, Hughes, Palliſer, &c.

The people of theſe baronies live well, are induſtrious, cleanly, and of good morals; the pooreſt farmer eats meat twice a week, and the table of the wealthy farmer is daily covered with beef, mutton, or fowl. The beverage is home-brewed ale and beer, of an excellent flavour and colour. The houſes of the pooreſt are well built and well thatched; all have out-offices for cattle, fowls, carts or cars. The people are well clothed, are ſtrong and laborious. The women do all manner of ruſtic work, ploughing excepted; they receive equal wages with the men.

In this delightful ſpot the greateſt harmony ſubſiſts between the landlord and the farmer; and it is common to meet the tenant at the landlord's table. Such is their averſion to idleneſs, that if a beggar is met in theſe baronies he is immediately handed from houſe to houſe until he is out of the barony.

The profeſſed religion here is the Roman Catholic; there are about one hundred to one Proteſtant.

Marriage is ſolemnized much in the ſame manner as with the Iriſh. The relations and friends bring a profuſion of viands of all kinds, and feaſting and dancing continues all the night; the bride ſits veiled at the head of the table, unleſs called out to dance, when the chair is filled by one of the bride-maids. At every marriage an apple is cut into ſmall pieces, and thrown among the croud; a cuſtom they brought from England, but the origin of it had not deſcended with it.

The produce of the ſoil in theſe baronies is great, the whole is under tillage, and near the ſea-ſhore they manure with the ſea-weed twice a year, and in the memory of the oldeſt man the ground has never been fallowed, but a plentiful crop obtained every year. The pariſh of Carne contains five hundred acres, all or moſtly under tillage; this pariſh pays 100l. a year for tithes to the rector. The church-land of Carne contains ſixty acres, of which forty are ploughed, and pays to the rector 14l. 14s. and to the landlord 90l. a year.

Fuel is ſcarce in this diſtrict; the chief firing is furze, planted on the tops of all the dikes; theſe are cut and dried, and bring a good return. Along the coaſt there has formerly been a bog or turbary, which has been encroached on by the ſea, ſo much that now it is covered with ſand, and that at high water, with many feet of the watry element. The great expence of cutting and drying this turf renders this kind of fuel too dear for the common people. In this turbary, many feet under the ſea at high water, trees are daily found, and ſome dug up; they conſiſt chiefly of oak, fir, and hazle.

Mr. Vallancey then adds a vocabulary of the language of theſe baronies, which ſhews it to be radically the ſame with the Engliſh. He ſubjoins an old ſong in the dialect, the ſubject of which is the game at ball called Camánn or Hurley. It opens thus.

Fade teil thee zo lournagh, co Jone, zo knaggee.
Th' weitheſt all curcagh, waſur, an cornee.
Lidge w'ous ana milagh, tis gay an louthee,
Huck nigher, y'art ſcudden, fartoo zo hachee.

What ails you ſo melancholy, quoth John, ſo croſs,
You ſeem all ſnappiſh, uneaſy and fretful:
Lie with us on the clover, 'tis fair and ſheltered;
Come nearer, you're rubbing your back, why ſo ill tempered.

A Deſcriptive Account of the Fort of Ardnorcher or Horſeleap, near Kilbeggan, in the County of Weſtmeath, Ireland; with Conjectures concerning its Uſe, and the Time of its Erection. By Mr. JOHN BROWNRIGG.

THIS work is popularly attributed to Sir Hugh de Lacy, but Mr. Brownrigg is convinced that it was originally a conſtruction of the ancient Iriſh, and was of great antiquity before his time. When De Lacy was made governor of Meath by Henry II. he not only erected many new fortifications, but converted all ancient buildings to purpoſes of defence, and ſtrengthened old fortreſſes with additional works of lime and ſtone. The moat (ſo called) of Ardnorcher appears to have offered itſelf to him as a ſtrong link in his chain of forts and caſtles. It is a conical eminence, at the end of a long and narrow ridge, ſurrounded by a trench and mound of earth, and ſtrengthened by deep vallies, the beds of two rivulets. On the high mount are remains of a round tower and ſtone wall. The only entire piece of building is the two piers of the draw-bridge and lower gate, now vulgarly called the *Horſeleap*, from a tradition of its being leaped acroſs by an Engliſh knight to eſcape from a hot purſuit. The word *Ard-an-orcher* in Iriſh ſignifies the *fort of ſlaughter*.

An Account of an Ancient Sepulcre diſcovered in the County of Kildare, Ireland, in the Year 1788. *By* William Beauford, *A. B.*

THIS ſepulcre juſt appeared above the ground, and was compoſed of large flat ſtones, forming a cavity, in which was a ſkeleton in a ſitting poſture. By his ſide was an urn of baked earth. The monument is conjectured by Mr. Beauford to have been probably of Daniſh origin; and the uſe of the urn, to have held a mixture of meal and water, for the ſubſiſtence of the corpſe during his paſſage to the other world.

Deſcription of an Ancient Monument in the Church of Luſk, in the County of Dublin. By Colonel Charles Vallancey, *F.R.S. &c. &c.*

THIS tombſtone was found in the year 1753, and a fair drawing then made of it. It is inſcribed with the names of Walter Dermond and his wife, and has rude figures upon it denoting the Trinity. What is ſingular in this monument is, that by the ſide of the figure of Chriſt are *two hands* open, which Mr. Vallancey conceives to be of hieroglyphical import. No ſymbol was more in uſe with the Ægyptians and ancient Iriſh than the *hand*: it was the ſign armorial of the kings of Ireland, as it ſtill is of the O'Brien family. In all the eaſtern languages the word hand had a variety of ſignifications, particularly denoting power, ability, excellence, protection, and the like. The Iriſh word *man*, hand, is by Mr. Vallancey derived from the Perſian and Arabic *menn* benevolent or propitious; and the Ægyptian word had the ſame metaphorical ſignifications. The *poſition* of the hand would, in hieroglyphical writing, vary its ſignification. An open or expanded hand was the ſymbol of benevolence or propitiouſneſs; and in the preſent monument the hands in this form are placed by the ſide of Chriſt, pointing to the names of the deceaſed, probably in correſpondence with the prayer "quorum animabus *propitietur* Chriſtus".

Mr. Vallancey then digreſſes to the ſymbols of the bird, mouſe, frog, and five arrows, recorded to have been ſent by the Scythians to Darius, which he attempts to explain by the rule of taking the *ſynomina* of each ſubject in the Hiberno-Scythian dialect; and this mode of interpreting hieroglyphics and picture-writing, inſtead of the more uſual one of explaining them by the *qualities* of the thing repreſented, he propoſes to the conſideration of the learned.

On the Silver Medal lately dug up in the Park of Dungannon, County of Tyrone, the Seat of the Right Hon. Lord Welles. By Col. Charles Vallancey.

THIS is one of the Arabian taliſmanic medals called *Ain*, from the firſt letter of the inſcription. The myſtical word is generally compoſed of three letters, viz. Ain, Lam, Ya, forming *Ali*, as in this medal. The cabbaliſtical Arabs attribute a great variety of myſterious powers to the letter *Ain*, the ſignification of which extends to a number of meanings, for the moſt part of ſomething ſuperior or excellent; and Mr. Vallancey ſays that it poſſeſſes nearly the ſame meanings in Iriſh. What is ſingular in this taliſman is, that the numerals under the inſcription are not Arabian, but European; whence Mr. Vallancey conjectures that it was ſtruck by the

Saracens, in Spain, at the requeſt of ſome European, who cauſed the date to be put in European figures.

Vide Plate XVI. Fig. 2. The word Ali is on the dated ſide, the letter Ya having a ſtar over it. The characters on the obverſe are unknown.

An Hiſtorical Eſſay on the Iriſh Stage. By JOSEPH C. WALKER, *Eſq. M.R.I.A. &c.*

THOUGH ſome ancient Iriſh poems are conducted in a kind of dramatic narrative, and in the dances of the vulgar Iriſh ſome traces of a rude ballet may be found, yet there is no proof that the ſtage properly ſo called exiſted in Ireland before the middle ages. The firſt record of the exhibition of plays which Mr. Walker has given, relates to the Chriſtmas repreſentation of myſteries or moralities before the E. of Kildare, Lord Lieutenant, in 1528. The actors here were the ſeveral corporations of Dublin, and it is probable that the cuſtom of theſe Chriſtmas entertainments had then been of ſome ſtanding. John Bale, biſhop of Oſſory, compoſed ſome dramatic pieces of a ſtill graver kind, and perfectly theological, which were acted at Kilkenny in 1552. In the 2d year of Elizabeth, an act which paſſed for the uniformity of Common Prayer, inflicts penalties on any perſon who in Enterludes, Plays, Songs, Rimes, &c. ſhall ſpeak any thing in derogation of the Prayer-book. In the reign of Charles I. in an Act for the chaſtiſement of Rogues, Vagabonds, &c. *Common Players of Enterludes*, and wandering Minſtrels, are enumerated. The Court, however, then countenanced dramatic amuſements; for a Maſter of the Revels was at this time placed on the eſtabliſhment, and under his direction a Theatre was built in Werburgh-ſtreet, Dublin, in 1635. This houſe cloſed in 1641; and that in Orange-ſtreet, now Smock-alley, was built in 1661. It appears, however, that in the ſubſequent troubles, theatrical amuſements had declined, ſince, according to Cibber, no actors could be found to preſent a play after the battle of the Boyne. From this period, the hiſtory of the Iriſh ſtage is minutely recorded by various writers.

Actes de la Societe d'Hiſtoire Naturelle de Paris, &c.

Tranſactions of the Society of Natural Hiſtory in Paris.

Vol. I. Part I. 1792.

ART. I. *A Diſcourſe on the Origin and Progreſs of Natural Hiſtory in France. By* AUBIN-LOUIS MILLIN.

A Knowledge of the properties of the three kingdoms of nature was in France, as in other countries of Europe, firſt a part of medicine, and chiefly exiſted in compilations from ancient authors, made by the monks. The firſt French writer who can properly be reckoned among the naturaliſts, is John Ruel, who publiſhed his treatiſe on plants in 1531. Leſcluſe, better known under the name of Cluſius, was a native of Arras, though from his being a profeſſor at Leyden, he is uſually claſſed among the Dutch writers. Pena and Dalechamp were next, the latter of whom gave a general hiſtory of plants. Henry IV. cauſed to be painted by Rabel a collection of plants, or rather of flowers; and he inſtituted the botanic gardens of Paris and Montpellier. At this period, Richer de Belleval, profeſſor at Montpellier, publiſhed his Onomatology, in which are ſome uſeful ideas on the theory of nomenclature. Twenty years after the death of Henry IV. Labroſſe, ſuperintendant of the king's garden, obtained Cardinal Richlieu's protection for that eſtabliſhment. But it was reſerved for Louis XIV. to give natural hiſtory the importance it has ſince poſſeſſed. His liberalities, directed by his firſt phyſician Fagon, enriched the garden with plants, and he founded the cabinet. Tournefort was ſent to the Levant, and Plumier to America, to collect exotics, and the academies of Paris and Montpellier were inſtituted.

The age of Tournefort became that of botanical ſplendour in France. His method, founded on the corolla, was eagerly adopted on account of its apparent facility; but he particularly owed his fame to the accuracy with which he diſtinguiſhed the genera. He may be conſidered as the founder of the Pariſian Flora, his Hiſtory of the Plants round Páris being a model of its kind.

Vaillant ſucceeded him. He beſtowed further attention on the diſtribution of genera, and particularly of ſpecies. He gave a good Flora of Paris with excellent figures. He projected a reform of Tournefort's method, and even a new one of his own; and he paid more regard to the cryptogamous claſs, then little known. But his greateſt merit conſiſted in giving clearer explanations on the ſexes of vegetables. His academical diſcourſe on this ſubject, though interſperſed with errors, is full of good obſervations. Others had preceded him in this diſcovery, but none had ſo well explained the myſtery of the fecundation of plants. In this he had to combat the reputation of Tournefort, who would never receive it.

A number of naturaliſts then aroſe in France. Plumier deſcribed the plants of America, eſpecially the ferns. Feulliée publiſhed his voyages to Peru. Barrere travelled through Provence and Spain. Dodart's work, conſiſting of 131 plates, was printed at the expence of Louis XIV. But the fineſt work of this kind, proceeding from the munificence of that king, was the ſuperb collection of animals and plants, painted on vellum by Aubriet, begun by order of Gaſton duke of Orleans, and uninterruptedly continued to the preſent time by different maſters. It is compoſed of more than 60 volumes, and is a maſterpiece of art, but not ſo valuable to ſcience, the generical characters not being given, except for a few years paſt. Some plants, however, now no longer exiſting, are preſerved in it. Gaſton was a great promoter of botanical ſtudies. He delighted in plants, and collected a great number of exotics in his garden of Blois, a catalogue of which was publiſhed by Moriſon. Natural hiſtory was alſo at this time allied to objects of common utility. Lemery compoſed his hiſtory of drugs, and Geoffroy his Materia Medica. The chymiſts of the Academy ſubmitted a great number of plants to analyſis by fire; and various uſeful vegetables and animals were naturaliſed and tranſplanted. The miſſionaries and Jeſuits diſperſed over the globe communicated various informations reſpecting the objects of nature, though fewer than might have been expected.

Natural hiſtory was now cultivated with great ardour, but the want of a general ſyſtem of arrangement began to be ſeverely felt, particularly with reſpect to the vegetable creation. At length Linnæus publiſhed his ſexual ſyſtem, and order ſucceeded to confuſion.

The French naturaliſts had not carried their reſearches into the animal kingdom ſo far as into the vegetable, but Belon had tolerably deſcribed birds and fiſhes, and Rondelet had publiſhed an ill-digeſted compilation on fiſhes. Quadrupeds were the beſt known, and many rare ones were kept in the king's menagery. The Academy publiſhed deſcriptions and engravings of ſeveral, with their anatomy. No works on inſects had appeared in France, except ſome economical ones on ſilk-worms and bees, till the great Reaumur applied himſelf with indefatigable labour to ſtudy all the particulars of their hiſtory. Nothing but method was wanting to perfect his work; but it was reſerved for Linnæus to be the founder of ſyſtematic entomology, as he had been of botany. Geoffroy gave a hiſtory of the inſects round Paris, after a method chiefly taken from that of Linnæus, in which he introduced ſpecific names, but not trivial ones. Reaumur publiſhed ſome memoirs concerning the Molluſca and Teſtaceous Vermes. D'Argenville ranks among the Conchyliologiſts, but his work is little eſteemed but for its plates. Geoffroy's little treatiſe on the ſhells around Paris is a model of its kind. Since that period, the moſt important French work on this ſubject is Adanſon's Voyage to Senegal, but it wants method. Reaumur alſo attended to the Zoophytes, and made ſome experiments on coral; but he denied their animal nature, a diſcovery due to Peyſſonel, French conſul at Smyrna. The Abbé Diquemarre has contributed moſt to the later knowledge of vermes and zoophytes.

Reaumur left a fine cabinet of birds. By its aſſiſtance his pupil Briſſon compoſed his Ornithology, in which birds are claſſed according to the form of their feet. It is an uſeful work, though the want of trivial names renders it difficult. Barrere, who travelled into equinoctial France, followed his ſteps.

Bernard de Paliſſy, a potter at Angers, was the firſt Frenchman who wrote rationally on Mineralogy, which ſcience he eſpecially applied to glaſs-making and pottery. He was the firſt who advanced that foſſil ſhells were not a relic of the deluge, but had been from time immemorial depoſited in the earths where they are found. Tournefort imagined that minerals, like plants and animals, had their growth, life and death. In late times, mineralogy has been the part of natural hiſtory moſt ſtudied in France. Dolback contributed greatly to diffuſe a taſte for it by tranſlating Wallerius, at the requeſt of Rouelle. Rouelle poſſeſſed one of the firſt cabinets of mineralogy, but the catalogue of Davila drawn up by Romé de Lille was what chiefly inſpired the paſſion for ſuch collections. The Cryſtallography of this laſt writer is one of the moſt brilliant productions of French mineralogy; though the idea was originally that of Linnæus. The great ſervices of Romé de Lille to the ſcience were not crowned with favour equal to their merit. He died in the year this diſcourſe was written, and left a cabinet in which his ſyſtem is fully diſplayed and demonſtrated.

The culture and phyſiology of vegetables have been attended to with ſucceſs by Duhamel, Thouin, and Poivre.

Of French engravings of ſubjects of Natural Hiſtory ſome have been mentioned. Buffon's Birds were the firſt great work with coloured plates; and they have been ſucceeded by others of great merit publiſhed by Brouſſonet, l'Heritier, Olivier, Dagoti, Bulliard, &c.

In the criticiſm and Bibliography of Natural Hiſtory, may be cited Seguier's Bibliotheca Botanica, Heriſſant's catalogue of French works in Natural Hiſtory. Bochart's

Fig. 1.

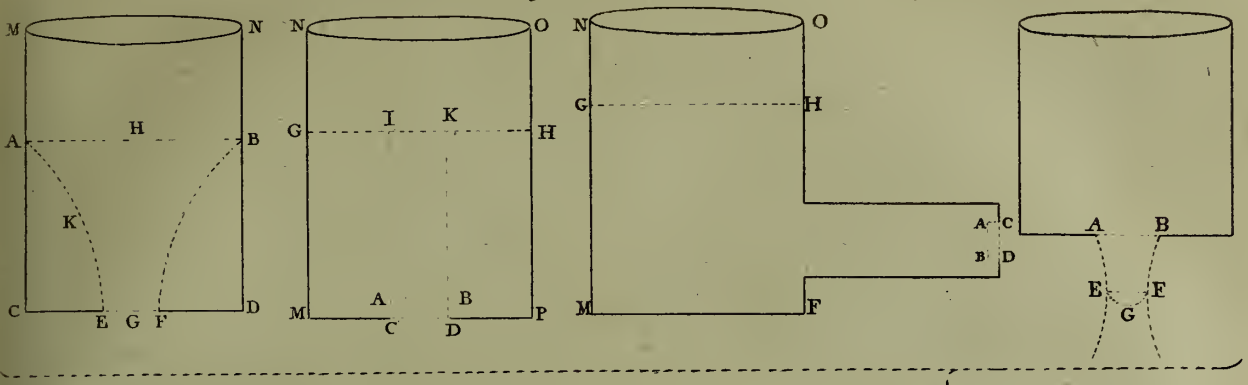
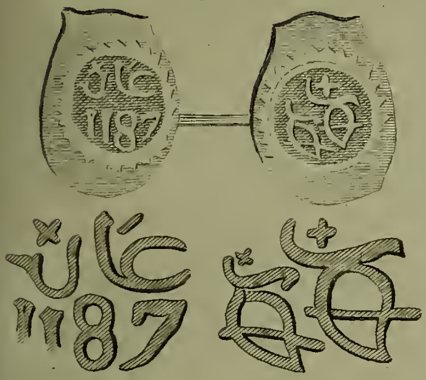


Fig. 2.



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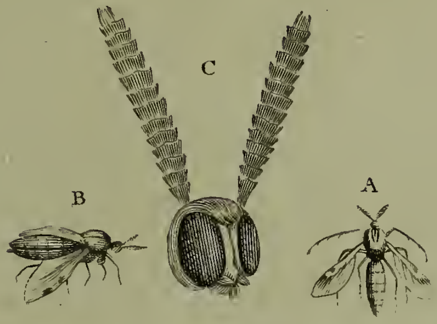

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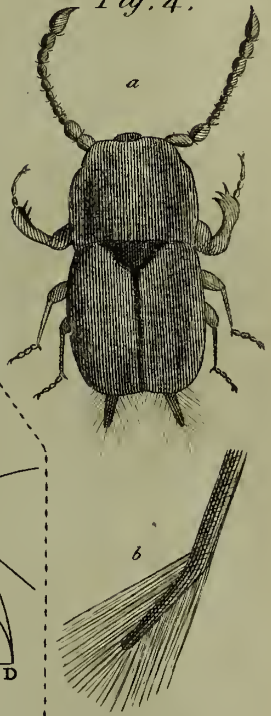

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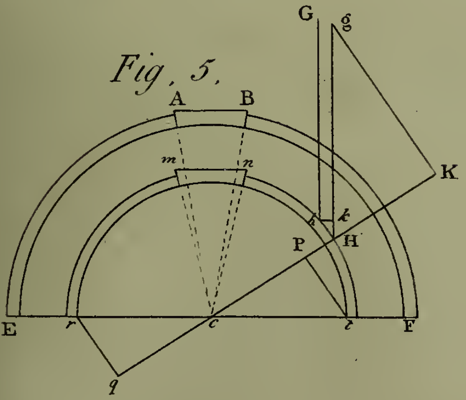

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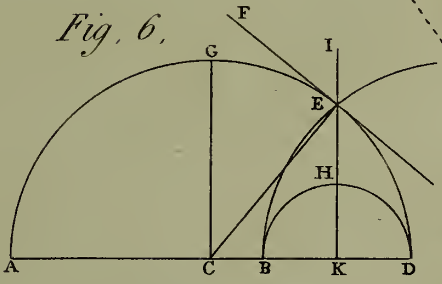

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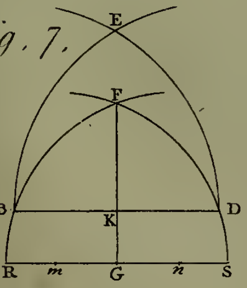

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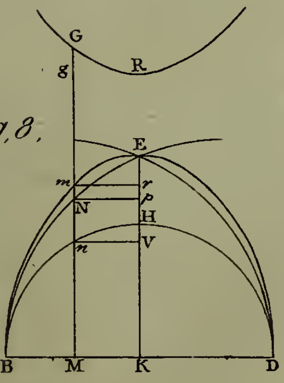

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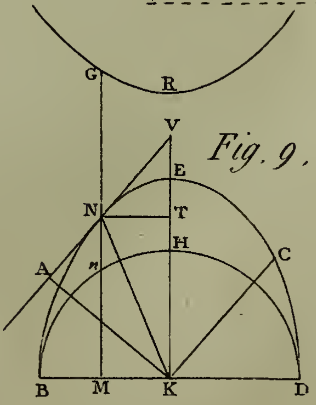

chart's Hiſtory of Biblical animals, Mahudel on Aſbeſtus, and Caylus on Papyrus. The author of this Diſcourſe has publiſhed a Diſſertation on the Thus of the ancients, and a Homeric Mineralogy, which is to be followed by a Zoology and Phytography from the ſame poet.

The improvements of Linnæus were ſlowly and reluctantly received into France. One cauſe of this was the attachment to Tournefort's method, kept up by Bernard de Juſſieu and other great botaniſts. Linnæus had, however, a zealous partiſan in M. Dayen, afterwards Marechal de Noailles; and the ſexual ſyſtem was entirely received by Sauvage and Gouan at Montpellier, Gerard in Provence, and le Monier in Paris. D'Alibard was the firſt who adopted this ſyſtem and the uſe of trivial names in his Flora of Paris, and Barbier Dubourg ſoon followed him.

The Zoological claſſifications of Linnæus were long diſregarded in France, particularly through the ſplendid reputation of Buffon, who charmed by the magic of his ſtyle, and threw all poſſible contempt upon ſyſtems and methods. His works, however, contain many curious facts in Zoology, and he contributed greatly to extend a taſte for Natural Hiſtory, both by his works, and by his credit. The embelliſhment and enlargement of the public Garden of Plants are due to his ſervices.

The eſtabliſhment of public and private courſes of lectures was greatly ſerviceable to the ſcience. The firſt example of theſe was given by B. de Paliſſy, before mentioned. Dictionaries and abridgements have rather been hurtful to the true progreſs of ſcience, yet have preſented a great number of facts in a commodious form.

In the latter years, and ſince the death of Buffon, a new generation aroſe, who embraced the true principles of the Linnean ſchool. In the year 1788 they formed a ſociety under the title of the Linnean; but the diſadvantages to which it was expoſed, in common with all the non-privileged ſocieties, under the old government, and the jealouſy of ſome of the protected literary bodies, ſoon cauſed its diſſolution. After the revolution, its founders, however, reunited, extended their plan, and inſtituted the preſent Society of Natural Hiſtory, which was joined by all the naturaliſts of the capital. They firſt met at a member's houſe, but when grown numerous, they hired their preſent apartments. The object of their labours is Natural Hiſtory in general, but eſpecially that of France, and in particular, of the environs of Paris. The territory to which they are to extend their reſearches, is a circle round Paris, of which the radius is the diſtance to Fontainbleau. A topographic chart divided into ſquares, is to be diſpoſed for the reception of notices of diſcoveries in the three kingdoms. A general and ſyſtematic catalogue is to be formed of all the objects already diſcovered within this diſtrict, arranged in all its parts according to the method of Linnæus, except that, in Mineralogy, it is to follow that of Romé de Lille. New reſearches are alſo to be made by means of periodical excurſions taken by the Society, either in the country, at the proper ſeaſons of the year, or to gardens, muſeums, &c. Three members for each of the three kingdoms of nature muſt neceſſarily attend theſe excurſions, of which a circumſtantial relation is to be depoſited in the archives of the Society. All learned ſtrangers are invited to favour the Society with their ideas and diſcoveries.

ART.

Art. II. *Balſamita.* *By* M. Desfontaines.

LINNÆUS, with other modern botaniſts, has rejected Vaillant's genus of *Balſamita*, which, however, the preſent writer thinks founded on ſuch diſtinct and eaſy characters, that it ought to be reſtored, with a few changes. He thus deſcribes it.

Balsamita. Vail. Acad. 1719. *Char. Gen.* Calyx com. imbricatus, flores omnes floſculoſi, quinquedentati, pappus nullus, receptaculum nudum. *Obſ.* Differs from Chryſanthemum in having no ſemifloſculous flowers: from Tanacetum in having them all hermaphrodite.

1. *B. grandiflora* foliis dentatis, radicalibus ſpathulato-ovatis, oblongis, caulinis lanceolatis, caule ſimplici, hirſuto, unifloro. Hab. near Algiers in the corn fields.
2. *B. virgata* ramis unifloris, foliis glabris inferioribus lanceolatis, ſerratis, ſuperioribus lineari-ſubulatis, integerrimis. Cotula grandis Linn. Hab. near Nice.
3. *B. Agerati-folia.* Chryſanthemum floſculoſum Linn. Hab. Crete.
4. *B. major.* Tanacetum Balſamita Linn.

Art. III. *Ardea Gularis.* *By* M. Bosc.

ARDEA occipite criſta dependente, corpore fuſco-nigreſcente, gula alba. Hab. ad fluv. Senegal.

This ſpecies of Heron, which appears hitherto unknown to the naturaliſts, greatly reſembles, both in form and dimenſions, the *Ardea Garzetta* and *Aigretta.* It differs by its colour, which is a deep fulvous with a violet tinge, and by the long feathers in the occiput in the male, which are like thoſe of the male of the *Ardea Cinerea* and *Nyctocorax.* The *Ardea Gularis* is leſs bulky and taller than the *Aigretta,* and leſs bulky and lower than the *Garzetta.* M. Rouſſillon to whom the communication of this bird is due, relates that he ſaw it ſolitary on the banks of the Senegal, while the *A. Garzetta* was there in numerous flocks. Its manner of feeding and habitudes are the ſame.

Art. IV. *Mutillæ diſcovered in France.* *By the* Abbé Latreille.

MUTILLA is a genus of inſects, of the order of Hymenoptera of Linnæus, and Syniſtates of Fabricius. The Linnean characters are inſufficient to diſcriminate this genus, the true marks of which muſt be taken from the antennæ and organs of the mouth. They are thus eſtabliſhed by this writer.

Mutilla. *Gen. Char. Antennæ* filiform, ſhorter than the corſlet, compoſed of twelve indiſtinct joints, of which the firſt is elongated and curved. *Antennulæ*, the anterior nearly twice as long as the poſterior, inſerted on the ſummit of the jaw, ſecond and third joints conical and ſwelled. No *wings* in the mules.

1. *Mutilla diadema.* M. very black; abdomen with two points at the baſe, a ray in the middle, interrupted, yellow, and a ſmall white line at the extremity. Found in Provence.

2. *Mutilla europæa.* M. briſtly, black; corſlet tawny; rings of the abdomen bordered with white. (Apterous). M. briſtly, black; corſlet tawny; abdomen with two white bands. (Winged). All France, but rare.

3. *Mutilla erythrocephala.* M. briſtly, black; antennæ, head, and corſlet, tawny; rings of the abdomen bordered with white. (Mule). In Provence.

4. *Mutilla maura.* M. briſtly, black; corſlet tawny, the back of the head and four ſpots on the abdomen, white. (Mule). In the ſouthern provinces.

5. *Mutilla interrupta.* M. briſtly, black; corſlet tawny; abdomen with two white bands, the firſt interrupted. (Mule). In Provence.

6. *Mutilla rufipes.* M. briſtly, black; antennæ and corſlet tawny, abdomen with a point and two approaching bands white. (Mule). M. briſtly, black; corſlet tawny anteriorly; abdomen with two white bands. (Winged). Frequent in the ſouthern provinces.

7. *Mutilla ſcutellaris.* M. briſtly, black; attachment of the wings and ſpot in place of the ſcutcheon, tawny; abdomen with white bands. (Winged). In Angoumois.

8. *Mutilla calva.* M. briſtly, black; occiput and corſlet tawny; rings of the abdomen bordered with white. (Mule). Common in Provence, Angoumois and Limouſin.

9. *Mutilla bipunctata.* M. briſtly, black; corſlet tawny; abdomen with two white points and bands. (Mule). In Provence.

10. *Mutilla punctata.* M. briſtly, black; antennæ and corſlet tawny; ſecond ring of the abdomen marked with two ſpots and two white points. (Mule). In Provence.

11. *Mutilla dimidiata.* M. briſtly, black; antennæ, corſlet, and baſe of the abdomen, tawny. (Mule). In Angoumois and Alſace.

12. *Mutilla lævis.* M. ſmooth, black; back and feet tawny; ſecond and fifth ring bordered with white. (Winged.) In Angoumois.

ART. V. *Obſervations on a Variety of Primitive Rocks or Granites, on preſenting the Society of Natural Hiſtory of Paris with a Series of Specimens of Rock afterwards to be treated of; and Reflections on the Means of meliorating and ſimplifying the Nomenclature of Lithology. By* M. LE FEBURE, *Mine Engineer.*

THE fragments of rock preſented, ſhew in their fractures cryſtals of Feldſpar, Quartz, Schoerl, Mica, Steatites, and ſometimes Garnets, diſſeminated in a cement of quartz more or leſs argillaceous, of the nature of Jaſper. 1. When in the cement of this rock cryſtals of Feldſpar alone are found, it has hitherto been called *Porphyry.* 2. If the Feldſpar is found in combination with Quartz, Schoerl, Mica, &c. it has been called in France *mixed or compound rock.* In Hungary all this kind is called *Saxum metalliferum.* Theſe ſtones differ from Granite in having a cement. From Breccias, becauſe the latter preſent only fragments united by a gluten; whereas in the rocks in queſtion, the angles of cryſtallization of the different ſtone-ſalts may generally be diſtinguiſhed. They differ from Pudding-ſtone, becauſe the parts diffuſed in the cement have not loſt their angles, whereas in the Pudding-ſtones they appear rounded as by friction. The pieces preſented were collected in the Crapack chain, the mountains of Carniola, the Alps of Dauphiné, the Voſges, the Bourbonnois, and Britany. They are found to accompany the primitive rocks or Granites,

nites, either depoſited in the fiſſures and veins of theſe mountains, or amaſſed in their vicinity.

Admitting with the Lithologiſts, that Granites or primitive rocks reſult from the cryſtallization of the ſtone-ſalts which conſtitute them; the writer explains in the following manner the formation of theſe ſuperjacent rocks, which differ from the ſubjacent only by the cement which binds the cryſtallized ſubſtances.

When the firſt products of cryſtallization have been precipitated, depoſited more or leſs confuſedly according to circumſtances, the latter-formed cryſtals are in a denſer liquid, a *mother water of cryſtallization*; in which they are ſurrounded by a mud compoſed of all the matters that were incapable of cryſtallization. This oppoſes their aggregation, and they have been depoſited together with the ſediment in which we find them enchaſed. Being laſt formed, they naturally occupy either the upper parts of the primitive rocks, or the fiſſures which they have left in ſhrinking. Whatever be thought of this hypotheſis, the facts concerning the rocks in queſtion, their difference from Granite and their ſituations, may be averred; they are therefore to be regarded only as ſpecies and varieties of the great claſs of primitive rocks. Upon this principle, the nomenclature of Lithology may be ſimplified. Thus, a general *Claſs of Primitive Rocks* may be formed, conſiſting of all the ſtone-ſalts variouſly cryſtallized which compoſe the great maſſes of our globe in which are neither animal nor vegetable exuviæ. Under this may be ranged *Species* with their *Varieties*. For example,

Species 1. *Primitive Rocks by ſediment.* (Porphyries).

Species 2. *Primitive Rocks of aggregation.* (Granites).

Species 3. *Primitive foliated Rocks of aggregation.* (Gneiſs).

Species 4. *Primitive Magneſian Rocks*; ſoft to touch, or of rare cryſtallizations. (Serpentines, Steatites, Talks).

Art. VI. *Buceros Africanus. The African Calao.* By M. Geoffroy, *jun.*

BUCEROS niger remigibus majoribus albis, roſtro nigro, cornu antrorſum aperto; mas gutture rubro; fæmina cæruleo. Hab. in Africa, præſertim ad fluvium Senegal. *Hydrocorax Africanus,* Briſs. *Buceros Africanus and Buceros Abyſſinicus,* Linn. *Brac ou Calao d'Afrique, et Grand Calao dAbyſſinie,* Buf. *African and Abyſſinian Hornbill,* Lath. Syn.

The horn which diſtinguiſhes this bird is thus deſcribed by Mr. Geoffroy. At the baſe of the upper mandible is an excreſcence of two inches in height, of the ſame ſubſtance with the bill, but much thinner, and which yields to preſſure. One might ſuppoſe it to have been cut. Its length is three inches. It is open, and at its aperture preſents the form of a club at cards or a lance iron: the opening is an inch long, and an inch and a half wide: on the inſide is a black membrane, the uſe of which is to prevent the introduction of any foreign body into the horn, which communicates interiorly with the head. The bird when young has not the horn open; it is then of a ſemicircular form.

All the authors who have mentioned this bird, have fallen into a groſs error. Some have deſcribed the bill alone; others have deſcribed it without having known it. All, in fine, have ſuppoſed that the horny excreſcence was only open by accident. After this idea P. Labat has given a bad figure of this bird, under the name of

Monoceros, in which he brings forward the horn as far as the bill. Briſſon and Buffon have followed this error. But the preſent writer, who has ſeen and killed a number of them, both males and females, aſſerts it to be as above deſcribed. Even in the young bird, when the excreſcence has no aperture, the horn is not prolonged: it is of the ſame length with that of the adult, of the form of a half-diſk, which at the end of the ſecond year becomes cleft at the extremity, and ſhows an aperture as deſcribed. From this obſervation it appears certain that Buffon's Abyſſinian Calao is only the young of the African.

The Calao has a heavy gait, a flight not rapid, low, and very ſhort. The male and female are always ſeen together, ſometimes two females to a male, never more. It feeds on inſects and lizards. The Negroes call it *Guéminte*, and regard it as ſacred, never killing it themſelves, and preventing the Europeans from firing at it. They imagine that the death of one gives colds to the whole diſtrict. When the writer had killed one, they reproached him ſeverely, and all put their noſes to the excreſcence to ſecure themſelves from the conſequences. The Moors of Senegal have not this ſuperſtition. The African Calao is not common on the coaſts: it is of a very miſtruſtful diſpoſition.

Art. VII. *Ebenus Pinnata.* By M. Desfontaines.

EBENUS *pinnata* Hort. Kew. *E. caule herbaceo, foliis impari-pennatis, foliolis lineari-lanceolatis, ſericeis, pedunculis axillaribus longiſſimis aphyllis.* Flowers in May. Grows on the dry uncultivated hills in the vicinity of Tunis and Algiers.

Art. VIII. *Hellenium Quadridentatum.* By M. Labillardiere.

HELLENIUM *foliis integris, ſubaveniis, lanceolatis, baſi latioribus, floſculis quadridentatis.* The florets of this plant have but four teeth and four ſtamina, by which they differ from thoſe of the *H. autumnale* of Linnæus. Nor is it that *Hellenium* with linear, entire, ſmooth leaves, of Miller, which he calls Baſtard Sun-flower, with a longer and narrower leaf, and which, according to Vaillant, is a *Corona Solis.*

Native of Louiſiana. Flowers in ſummer and autumn.

Art. IX. *Sepia Rugoſa.* By M. Bosc.

SEPIA *corpore ecaudato, rugoſo, tentaculis pedunculatis multis, cotyledonibus approximatis. Hab. in Oceano.* It is neceſſary to compare this ſpecies of Cuttle-fiſh with the *Sepia octopodia* of Linnæus to perceive their difference, which conſiſts in the chagrined, almoſt wrinkled, ſkin of the preſent, and the cloſeneſs of the cotyledons on its feelers. To the ſpecific name of *S. octopodia* therefore ought to be added, *corpore lævi, cotyledonibus diſtantibus.* The colour of the *S. rugoſa* is a vinous brown, which appears to have been red during its life. It comes from the ſeas near Senegal, and approaches that figured by Seba, Vol. 3, pl. 2, n. 6 and 7. Poſſibly it may be that red muſky kind, of which the Chineſe are ſaid to make Indian ink.

ART. X. *Lacerta Exanthematica.* By M. BOSC.

LACERTA *cauda ſemicarinata, corpore dorſo maculis ſuborbiculatis albis, abdomine faſciis fuſcis, lineis duabus nigris pone oculum.* This Lizard belongs to the firſt diviſion of Linnæus and Cepede. It ſhould be placed next to the *L. Monitor*, with which it has ſeveral points of reſemblance. It differs from it in its tail, being carinated only on one ſide, and having no tubercles on the ſcales. Found in Senegal.

ART. XI. *Fumaria Corymboſa.* By M. DESFONTAINES.

FUMARIA *foliis pinnatis, foliolis flabelliformibus, lobatis, inciſis, floribus ſpicato-corrymboſis, ſiliculis tuberculoſis, monoſpermis, pedicellis deflexis.* This ſpecies of Fumitory, with purple and white flowers, grows in the clefts of mount Atlas, near Thlemſen and Maſcara in Algiers. Flowers in May.

ART. XII. *Determination of the genus Ips and its Congeners.* By M. FABRICIUS.

AFTER ſome preliminary obſervations on ſyſtematic entomology and its difficulties, M. Fabricius proceeds to obſerve, that the genus *Ips*, though rightly characteriſed, had received many ſpecies, which did not properly belong it. For this reaſon, M. Olivier aboliſhed almoſt the whole genus, and conſtituted a new one under the ſame name, but with ſcarcely better ſucceſs. This has induced M. Fabricius to reviſe the genus and other kindred ones, and to arrange their ſpecies as follows.

IPS. *Palpi* quatuor æquales breviſſimi, articulo ultimo ovato. *Maxilla* bifida. *Labium* membranaceum, conicum, emarginatum. *Antennæ* perfoliatæ.

1. *I. Faſciata* atra, elytris faſciis duabus rufis, anteriore nigro maculata. Hab. in America boreali.
2. *I. Grandis* glabra, atra, elytris maculis duabus rufis. Hab. in Africa æquinox.
3. *I. Punctata* atra, elytris rufis, macula magna atra. Hab. in Europa auſtral.
4. *I. Bipuſtulata* atra, elytris macula baſeos rufa. Hab. Halæ Saxon.
5. *I. Dorſalis* pallida, coleoptris macula media nigra. Hab. in Europa auſtr.
6. *I. 4-puſtulata* nigra, elytris punctis duobus ferrugineis. Hab. in Europa boreal.
7. *I. 6-puſtulata* nigra, elytris ſtriatis, maculis tribus rufis. Hab. in Europa boreal.
8. *I. Quadriguttata* atra, nitida, elytris maculis duabus albis, anteriore ſinuata. Hab. in Europa.
9. *I. Ferruginea* ferruginea elytris teſtaceis. Hab. in Germania.
10. *I. Nigripennis* rufa, antennis, elytris, pectoreque nigris. Hab. in Germaniæ arboribus.
11. *I. Hæmorrhoidalis rufa*, elytris nigris apice rufis. Hab. in Suecia.
12. *I. Rufipes* atra, capite, thorace, pedibuſque ferrugineis. Hab. in Norwegiæ fungis.
13. *I. Ænea* coccinea elytris æneis, immaculatis. Hab. Halæ Saxon.
14. *I. Humeralis* nigra, capite, thorace, elytrorum puncto baſeos, pedibuſque rufis. Hab. in Suecia.

15. *I. Lunata* nigra, elytris punᴄto baſeos lunulaque poſtica ferrugineis. Hab. Kiliæ Holſat.

16. *I. Rufifrons* atra, fronte, maculis duabus elytrorum, pedibuſque ferrugineis. Hab. in Anglia.

MYCETOPHAGUS. *Palpi* quatuor inæquales. *Maxilla* membranacea unidentata. *Labium* rotundatum integrum. *Antennæ* extrorſum craſſiores.

1. *M. Quadrimaculatus* rufus, thorace elytriſque nigris, his maculis duabus rufis. Hab. in Germaniæ boletis.

2. *M. Bicolor* niger ſubtus, antennis pedibuſque ferrugineis. Hab. in Americæ merid. Inſul.

3. *M. Dermeſtoides* fuſcus, abdomine pedibuſque teſtaceis. Hab. in Germaniæ boletis.

4. *M. Atomarius* niger, elytris punᴄtis faſciaque poſtica fulvis. Hab. Halæ Saxon.

5. *M. Multipunᴄtatus* rufus elytris ſubſtriatis, punᴄtis rufis numeroſis. Hab. in Sueciæ boletis.

6. *M. Picicornis* ater, elytris ſtriatis, antennis pedibuſque piceis. Hab. in Americæ merid. Inſul.

7. *M. Sanguinicollis* ater, thorace elytrorumque maculis duabus pedibuſque rufis. Hab. Halæ Saxon.

8. *M. Piceus.* Piceus, elytris ſtriatis nigris, baſi faſciaque ferrugineis. Hab. in Germania.

9. *M. Punᴄtatus* piceus, elytris ſubpunᴄtatis nigris, baſi ferrugineis. Hab. in Germaniæ fungis.

10. *M. Nigricornis* flavus, antennis nigris. Hab. Halæ Saxon.

11. *M. Caſtaneus* ater, elytris ſtriatis, antennis pedibuſque caſtaneis. Hab. in Germania.

12. *M. Metallicus* æneus, pedibus ferrugineis. Hab. Halæ Saxon.

13. *M. Teſtaceus* teſtaceus, immaculatus. Hab. in Germaniæ boletis.

14. *M. Bifaſciatus* niger, elytris, faſciis duabus, punᴄtoque apicis ferrugineis. Hab. Halæ Saxon.

CYLONIUM. *Palpi* quatuor clavati articulo ultimo majori. *Labium* membranaceum, emarginatum. *Antennæ* perfoliatæ.

1. *C. Sulcatum* ferrugineum, thorace ſulcato. Hab. in Germania, ſub arborum corticibus.

2. *C. Elongatum* atrum, pedibus ferrugineis. Hab. in Europæ ligno antiquo.

3. *C. Filiforme* atrum, elytris ſulcatis baſi, pedibuſque ferrugineis. Hab. Halæ Saxon. in truncis quercus.

4. *C. Unidentatum* teſtaceum, thorace utrinque angulato. Hab. ſub arborum corticibus.

5. *C. Cellare* nigricans, antennarum clava teſtacea, thorace crenato. Hab. in Europæ quiſquiliis.

6. *C. Frumentarium* teſtaceum, thorace crenato, dorſo tricarinato. Hab. in Americæ merid. farina.

LYGDUS. *Palpi* quatuor breviſſimi, filiformes. *Maxilla* brevis, membranacea, bifida. *Labium* integrum. *Antennæ* clava ſolida. Antennarum articulo unico craſſiori.

1. *L. Politus* niger, antennis pedibuſque ferrugineis, thorace plano, oblongo, punctato. Hab. in boletis arboreis Europæ.

2. *L. Depreſſus* brunneus, pectore abdomineque nigricantibus, thorace oblongo pleno. Hab. Dreſdæ.

3. *L. Bipuſtulatus* glaber, elytris puncto ferrugineo. Hab. Halæ Saxon.

4. *L. Dentatus* niger, thorace ovato, plano, utrinque dentato. Hab. in America merid.

5. *L. Brunneus* ferrugineus, elytris lævibus teſtaceis. Hab. in Americæ inſul.

6. *L. Terebrans* oblongus, ferrugineus, elytris punctato-ſtriatis. Hab. in Germania ſub arbor. cortic.

7. *L. Juglandis* obſcurus, elytris ſtriatis, antennis pedibuſque teſtaceis. Hab. Halæ Saxon.

8. *L. Hyſteroides* ater, nitidus, antennis pedibuſque piceis. Hab. in Dania ſub arbor. cortic.

9. *L. Crenatus* niger, thorace rugoſo, elytris ſtriato-crenatis, maculis duabus. Hab. in Europa ſub arbor. cortic.

10. *L. Navalis* ferrugineo-fuſcus, oculis atris. Hab. in Nova Zelandia.

11. *L. Canaliculatus* obſcurus, thorace canaliculato, elytris ſtriatis brunneis. Hab. ſub arborum cortic.

12. *L. Nitidus* ater, glaber, nitidus, antennis pedibuſque ferrugineis. Hab. in Germania.

13. *L. Contractus* oblongus, ferrugineus, elytris punctato-ſtriatis, ſutura nigra. Hab. in Gallia ſub arbor. cortic.

Hypophlæus. *Palpi* quatuor æquales clavati. *Labium* elongatum membranaceum integrum. *Antennæ* extrorſum craſſiores utrinque ſerratæ.

1. *H. Caſtaneus* lævis, nitidus, caſtaneus, antennis nigris. Hab. ſub cortic Ulmi.

2. *H. Linearis* lævis, ater, elytris, antennis, pedibuſque teſtaceis. Hab. Pini ſylv. cortic. Germaniæ.

3. *H. Faſciatus* lævis, ater, elytris teſtaceis, faſcia atra. Hab. ſub cortice Quercus German.

4. *H. Depreſſus* lævis, ferrugineus, elytris ſubſtriatis. Hab. ſub ortice Quercus German.

5. *H. Bicolor* oblongus, rufus, elytris teſtaceis apice atris. Hab. in Gallia ſub arbor. cortic.

Art. XIII. *Antirrhinum Marginatum.* *By* M. Desfontaines.

ANTIRRHINUM foliis glaucis, lineari-lanceolatis, imis verticillatis, ſuperioribus ſparſis, floribus aggregatis, terminalibus, ſemine marginato.

Obſ. This ſpecies of Toadflax has a reſemblance to the *Antirrhinum bipunctatum Linn.* from which it principally differs by its procumbent ſtalks, its much larger flowers, and biennial roots. Found in the mountains of Tlemſen, in the clefts of rocks.

Art. XIV. *Crepis Virgata.* *By* M. Desfontaines.

CREPIS glabra, caule ſuperne nudo, pedunculis lateralibus paucis, centrali longioribus, foliis dentatis, petiolatis, inferioribus lato-lanceolatis. Grows in ſandy ſoils, and on the edges of fields about Tunis and Algiers. Flowers in April and May.

Art. XV. *Crepis Coronopifolia.* By M. Desfontaines.

CREPIS glaberrima, foliis pinnatifidis, foliolis linearibus, caule erecto paniculato, pedunculis filiformibus, calycibus farinoſis. Hab. Canary Iſles.

Art. XVI. *Ichneumon Hemipteron.* By M. Riche.

ICHNEUMON alis longitudine thoracis.

Obſ. This ſpecies ought to be ranged between the *I. ramicornis*, and *I. agilis* of Fabricius. It forms the ſtep between the winged and wingleſs Ichneumons. Its wings, too weak for flight, ſcarce ſerve to quicken its walk. It is among thoſe numerous organiſed beings, to which nature has added certain parts uſeleſs to their motions and functions, for the purpoſe of preſerving thoſe lineaments which mark the gradations from one ſpecies to another in the whole of the ſyſtem of nature. The wings of my ſpecimens of this inſect were not abortive, ſince they are furniſhed with well-defined nerves, and the animal moved them with eaſe. It is found in the Spring in dry ſpots about Paris.

Art. XVII. *Serropalpus.* By M. Bosc.

GEN. *Char.* *Palpi* quatuor inæquales; anteriores longiores, profunde ſerrati, quadriarticulati; articulo maximo, truncato, compreſſo, apice excavato patiliformi; poſteriores triarticulati, ſubclavati. *Labium* integrum hirſutum. *Maxillæ* arcuatæ liberæ. *Pedes* foſſori, femoribus compreſſis, tarſis quinque articulatis. Of the preceding new genus of inſects, eſtabliſhed by Hellenius in the Act. Academ. Upſal. 1786, two ſpecies have been given, the *S. ſtriatus* and *S. lævigatus*. M. Boſc adds another, the *Serropalpus variegatus*, corpore piceo, elytris teſtaceis, fuſco-irroratis. This ſpecies differs a good deal in appearance from the two former, but reſembles them in its generic character. However, the anterior feelers are more elongated, leſs angular, and leſs ſecuderiform than in the Swediſh figure; the anterior feet are not foſſorial, and their tarſus has only three joints inſtead of five. There is no ſcutellum. The *S. variegatus* is very rare. Found on plants in July, in the foreſt of Montmorency.

Art. XVIII. *Keroplatus.* By M. Bosc.

GEN. *Char.* *Hauſtellum* bilamellatum; *palpi* duo uniarticulati; *antennæ* oblongæ compreſſæ.

Keroplatus Tipuloides flaveſcens, fronte cornuta, thorace lineato, abdomine faſciato; alis maculatis. Hab. Pariſiis.

This inſect is particularly remarkable for the form of its antennæ, which can be compared to no others, and differ widely from thoſe of the claſs of *Antiliata* with which it is ranged. It forms the link between the *Oeſtra* and *Tipulæ*, having the characters of the mouth of the former, and the external appearance of the latter. Plate XVI. Fig. 3.

Explanation of the Plate.

A. The inſect of the natural ſize viewed from the back.
B. The ſame from the ſide.
C. The head and antennæ much magnified.

Art. XIX. *Acheta ſylveſtris.* *By* M. Bosc.

ACHETA alis nullis, elytris (mas) longitudine dimidii corporis, corpore fuſco, ſtylo (femina) lineari. Hab. Pariſiis.

This inſect, though very common in the woods round Paris, has not yet been deſcribed by any author. It is found in the larva ſtate in May, in which it remains till the end of July. It makes no hole in the ground, but when purſued hides itſelf under leaves, or in crevices of the turf.

Art. XX. *Locuſta Punctatiſſima.* *By* M. Bosc.

LOCUSTA aptera, viridis, thorace vittis duabus luteis, abdomine punctis numeroſis fuſcis, dorſo linea ferruginea. Hab. Pariſiis. This Locuſt is among thoſe without wings, and which call their females at the end of autumn with a little noiſe made by means of ſcales which are in the place of the wing-caſes. It is rare about Paris, but is met with on the borders of woods in September and October. It is undeſcribed, and in ſize ſhould follow the *L. Laxmani.*

Art. XXI. *Opatrum Plumigerum.* *By* M. Lermina.

OPATRUM piceum, compreſſum, alis linearibus a medio ad apicem pennatis. Hab. Pariſiis, ſub lapidibus.

The name of this inſect is derived from the ſingular ſtructure of its wings, repreſented in Plate XVI. Fig. 4.

Explanation. *a.* The inſect magnified. *b.* A wing, more magnified.

Art. XXII. *Lycoperdon Axatum.* *By* M. Bosc.

LYCOPERDON ſtipitatum, clavatum, ſtipite torto lignoſo ad apicem clavæ prælongo, clava lateribus lacerato-dehiſcente. Hab. ad Senegalem fluvium.

Art. XXIII. *Peat newly diſcovered in the Department of the Lower Seine.* *By* M. Deribaucour.

THIS peat-bank is ſituated at the village of Job, near Honfleur, on the banks of the Seine. It is on a plain, elevated about 100 feet from the level of the river, and croſſed by a ſtream. The peat is covered with ſix inches of vegetable earth, and 18 inches of tufa. It has been ſounded to the depth of 12 feet, the peat ſtill improving in quality. It is here and there croſſed by veins of white potters-clay, an inch in thickneſs. The peat is brown, intermixed with earthy layers, and of a foliated texture. It is noticed here, not only as an object of economical utility, but as one of the infrequent inſtances of *peat depoſited on elevated plains.*

ART. XXIV. *Atractylis Gummifera.* By M. DESFONTAINES.

ATRACTYLIS acaulis, foliis pinnatifidis, inæqualiter dentatis, dentibus ſpinoſis, foliolis calycinis exterioribus apice tricuſpidatis.—A. flore acauli, *Linn.*

This plant is very common in Algiers. It delights in uncultivated and ſandy places, on dry hills, and at the root of mountains expoſed to the ſun. It flowers in autumn, its leaves being then withered, which ſpring again at the commencement of winter, and continue green till May. From the receptacle and collar of the root flows an inodorous taſteleſs gum, of a yellowiſh white, appearing in little irregular globules of the bulk of a pea. The Moors and Arabs uſe it for bird-lime. The root and receptacle boiled and ſeaſoned with butter or oil, afford an agreeable and nutritious food, of great uſe in times of ſcarcity.

ART. XXV. *Zoology. Enquiries reſpecting a new Method of Claſſification of Quadrupeds, founded on the mechanical Structure of the bony Parts which ſerve for the Articulation of the lower Jaw.* By M. PINEL, *M. D.*

THE claſſification of quadrupeds has hitherto been founded on certain differences and reſemblances of external ſtructure, particularly with reſpect to the teeth and feet. This, however, in many inſtances proves an artificial method, bringing together ſpecies very diſſimilar in the moſt important circumſtances of their economy; nor does it ſeem poſſible to make arrangements founded upon this principle, much more perfect than has been already done by Linnæus, Briſſon, and others. But in the opinion of this writer, we are now arrived at an epoch in ſcience in which further progreſs in Zoology is to be made by ſearching out immutable diſtinctions of ſpecies and genera in the mechanical ſtructure of the internal parts, and eſpecially the bony fabric of the articulations, and the powers that move them. It is his plan, in eſtabliſhing a new claſſification of quadrupeds, to compare all the articulations of the body; but at preſent he has confined himſelf to that of the lower jaw, which is ſingularly varied in different genera, and may itſelf furniſh a number of ſpecific and generic characters, after preciſe and exact meaſurements.

He begins with the variations of the *zygomatic arch.* This, in carnivorous animals, as the cat and weaſel, forms a kind of flat arch, ſimilar to that called by mathematicians the *baſket-handle.* In the dog it is more like an irregular union of two arcs of a circle; in ſome ſpecies of monkey it approaches a ſtrait line, in others it is ſlightly curved in oppoſite directions, like an s. Its arch is ſmall in granivorous animals. In ſome herbivorous, its convexity is downwards, or contrary to that of the cat. But before he proceeds further, he makes ſome reflections on the application of mathematical ſcience to the ſtructure of animals. As the bony arches are far from repreſenting geometrical lines, and as they have a variety of breadth in different points, he draws a line intermediate to their two margins, and transfers this to paper in order to find its center by the ſimpleſt geometrical rules. He then values the arc, which is eaſily done if part of a circle; and if the curvature takes place in two different planes, he takes them ſeparately, and thus alſo meaſures the curvilinear angle which they form. As a circle, by the variation of its radius, eaſily adapts itſelf to an infinite variety of curvatures, it is to be kept to as much as poſſible. The curve called the baſket-handle is a very frequent one in the ſkeleton. It is formed by a central arc of a larger circle, of 60 degrees, and an arc of a ſmaller circle of 60 degrees on each ſide, by way of buttreſs. It reſembles half an ellipſis cut according to its greater diameter. Of this arc, the line joining its extremities is called its diameter; a perpendicular raiſed upon the center of the diameter, its ſagitta or arrow; and the two extremities, the ſpringing of the axis. To apply this to zoological deſcription — he would ſay of the Pole-cat, *In Marte domeſtica arcus zygomaticus quam proxime analogus curvæ dictæ a mathematicis* anſe de panier. *Relatio diametri ad ſagittam* : : 23 : 9. Of the Macoco Ape, *In Simia dicta Cinomolgo, proceſſus zygomaticus dirigitur quam proxime juxta lineam rectam.* Of the Rabbit, *In Cuniculo adulto proceſſus zygomaticus quam proxime arcum circularem æmulatur, cujus concavitas ſuperiora reſpicit, et cujus ſubtendens adæquat* 11 *lineas.*

There are not fewer variations in the form of the zygomatic foſſa viewed ſidewiſe, or rather in the contour of the terminations of the temporal muſcle. Theſe terminations are, the bony curved print which bounds its attachments above, the upper edge of the zygomatic arch, and the poſterior edge of the orbit, which together give a figure ſometimes triangular, ſometimes oval. The moſt ſtriking differences, thoſe in particular which determine the form of the vertex in different animals, ariſe from the diſpoſitions of the bony prints in which the ſuperior attachments of the temporal muſcle terminate. In carnivorous animals they form an eminence poſteriorly, ſo as to give a triangular figure to the interior part of the vertex; whereas in the ſheep, they form an irregular four-ſided figure, broader before than behind; the reverſe of which takes place in the ape. Another remarkable difference in theſe parts is, that in certain animals of the granivorous claſs the poſterior edge of the orbit is arched and very ſtrong, while it is only ligamentous in ſome of the carnivorous kinds, whence in their ſkeletons, the orbitary and zygomatic foſſas are confounded.

The lower jaw bone of quadrupeds is alſo fertile in varieties. In ſome, its two branches form a continued curve, as in the ape and elephant, therein reſembling the human jaw, which has no ſymphyſis in the adult; but in much the greater number the two branches unite at an acute angle. This the writer has found in the ſkeleton of a cat to be one of 60 degrees; in that of a rabbit, 45; of a mole, 30. Other curvatures in the lower jaw are capable of affording diſtinctive marks; as thoſe formed by its baſis or inferior edge on each ſide. This, in ſome, is a tolerably regular curve from the baſe of the condyle to the ſymphſis of the chin, in others it is variouſly interrupted. The coronoid apophyſis and the condyle alſo offer varieties in different animals, which correſpond with the general plan of nature in adopting theſe parts to the way of life, and may ſerve for generic and ſpecific diſtinctions. The lower jaw may further be conſidered as a lever, in which the power reſults from the traction of the temporal and maſſeter muſcles, the point of ſupport is the condyle, and the reſiſtance is the body placed between the teeth. The reciprocal diſtances of the power and the reſiſtance, from the point of ſupport, may be computed by means of perpendiculars let fall in their directions upon a line parallel to the axis of the lower jaw; and theſe will be found different in different ſpecies of animals.

It is evident that a claſſification upon theſe principles could not be formed without a great expence of time and labour, and a vaſt collection of animal ſkeletons. There is no doubt, however, that it would collect into the ſame diviſions thoſe families on which nature has impreſſed ſtrong marks of phyſiognomonical reſemblance; ſo that the anatomical arrangement would rather confirm than aboliſh the claſſification of nature. The writer promiſes in a future memoir to give examples of the application of his ſyſtem to each of the natural families of quadrupeds, by which he expects to eſtabliſh a ſelection of generic and ſpecific marks.

ART. XXVI. *Zootomy. Extract of Inſtructions for Naturaliſt Travellers.* By M. RICHARD.

THESE were drawn up for the uſe of a company of voyagers, and conſiſt of plain directions how to deſcribe and preſerve the various internal parts of the animal body, and what are the principal objects to be attended to in the ſtructure of each. They are arranged under twenty heads; but as they contain only ſubjects pointed out for enquiry, we ſhall paſs them over without abridgement.

ART. XXVII. *A new Species of Tuſſilago.* By M. VILLARS.

THE Tuſſilago was for a long time ſeparated from the Petaſites, till Linnæus united them in the ſame genus. He ſhewed that neither the flowers, commonly radiated in the Tuſſilago and floſculous in the Petaſites, nor the circumſtance of their appearing with or without the leaves, ſufficed to preſerve them two diſtinct genera; and the preſent ſpecies is an additional proof of this. It has been found wild in the Lyonnois. It is not noticed in the works of Linnæus, and only Micheli ſeems to have mentioned it. M. Villars thus characteriſes it.

Tuſſilago fragrans, thyrſo corymboſo, pedunculis ſubramoſis, floribus breviter radiatis, foliis acute crenatis, integris, reniformibus, ſubtus hirſutis. This ſpecies differs from the other known ones in the following circumſtances; 1. It flowers the earlieſt, towards the end of December. 2. Its leaves are entire, and accompany the flowers. 3. Its flowers are very fragrant. 4. They are truly radiated on the border.

M. Villars then proceeds to give a liſt and abridged deſcription of all the Tuſſilagos known in Europe. Theſe are, 2. *T. nivea.* 3. *T. alba*; Var. *T. Gmelini.* 4. *T. Petaſites.* 5. *T. hybrida.* 6. *T. alpina.* 7. *T. Farfara.* 8. *T. frigida.* 9. *T. ſpuria.* 10. *T. paradoxa.* 11. *T. diſcolor.* 12. *T. anandria.*

In ſome ſubjoined obſervations on the genus, he ſays, the moſt conſtant parts on which to found ſpecific characters in it are, 1. the indentations, fibres, and tiſſue of the leaves; 2. the diſpoſition and number of the flowers; 3. the hairs of the peduncles and form of the calyx; 4. the number, form, and ſex of the florets, and colour of the feather; 5. the form of the ſtigma. This laſt part, though minute and fugacious, he thinks ſufficient alone to diſtinguiſh all the ſpecies, even the *T. Petaſites* and *T. hybrida*, which approach ſo nearly.

ART.

Art. XXVIII. *Decumaria Sarmentoſa.* By M. Bosc.

DECUMARIA foliis inferioribus rotundatis, ſuperioribus ovato-lanceolatis, caule ſarmentoſo. Hab. in Carolina.

The genus *Decumaria,* left incomplete by Linnæus, has been reformed in the *Hort. Kewens,* and to this reformed genus belongs the above ſpecies. It grows in the ſwamps of S. Carolina. Its branches of flowers exhale a very agreeable odour. Its weak ſprays, ſupported by the branches of trees, often riſe to the ſummit of the talleſt.

Art. XXIX. *On the Diamonds of Braſil.* By M. D'Andrada.

THE province of *Serro Dofrio,* or Cold Mountain, called by the natives *Yritauray,* is that from which the diamonds are procured. It is a country very rich in mines of iron, antimony, zinc, tin, ſilver, and gold. The Pauliſts or inhabitants of the ancient Captainry of St. Vincent, were thoſe who diſcovered theſe mines, and in great part peopled the province. Antonio Soary was the firſt who viſited the *Serro Dofrio.* Gold only was at firſt got from it, but at length diamonds were diſcovered in the *Riacho Fundo,* and afterwards in the *Rio de Peixe.* A great number were alſo got from the river *Giquitignogna.* At length, at the cloſe of the year 1780 and the beginning of 1781, a horde of near 3000 ſmugglers, called Grimpeiros, diſcovered diamonds, and got an immenſe quantity of them, in the *Terra de Santo Antonio,* but were forced to abandon it to the royal farmers. The ſuſpicions were then confirmed that theſe mountains were the true matrix of the diamonds; but being more readily, and of a larger kind, procured in the beds of rivers, the farmers relinquiſhed the mountains, and made great eſtabliſhments on the river *Toucanbiruçu,* which bathes the vallies of this chain, and is near 80 leagues in length. It was found by excavations, that the whole layer of earth placed beneath the vegetable ſtratum contains more or fewer of ſcattered diamonds, attached to a gangue more or leſs ferruginous and compact, but never in veins or the ſides of the lodes.

The figure of the Braſil diamonds is various. Some are octahedral, formed by the union of two tetrahedral pyramids. This is the *Adamas octaedrus turbinatus* of Wallerius, or octahedral diamond of Romé de Lille. It is almoſt always found in the cruſt of mountains. Others are almoſt round, either from a proper cryſtallization, or attrition. They reſemble thoſe oriental ones which the Portugueſe call *Reboludos,* or rolled. Others are oblong, and ſeem to be the *Adamas hexaedrus tabellatus* of Wallerius. Theſe two laſt are commonly found in the beds of rivers, or the depoſitions of ſand on their banks, which laſt are formed of a layer of ferruginous ſand, with rolled flints, forming an ochraceous pudding-ſtone proceeding from the decompoſition of emery and muddy iron. It is called *Caſcalho;* and the layers, *Taboleiros,* when horizontal and in the plane of the bed of the river, but *Gopiara* when riſing in hills. If the matter contains much emery, it is called in Braſilian *Tabanhua canga,* black, or iron-ſtone.

In ſome places the *Caſcalho* is naked; in others, it is covered by a kind of vegetable mud, or by a fat reddiſh ſand, containing ſometimes rolled flints, and called *Piſarra.* The ſtratum beneath the *Caſcalho* is arenaceous ſchiſtus, or muddy iron ore in ſtone. It is alſo in the *Caſcalho* that gold is found in duſt and grains.

The mode of working is to turn the courſe of the ſtreams, in order to waſh the gravel and pick out the diamonds, or to break the *Caſcalho* with hammers, and waſh it in troughs. In this operation little water is uſed, very clear, and very little of the matter at a time. It is performed by black ſlaves, clad only with an apron; and all poſſible care is taken by numerous inſpectors that no diamonds ſhould be concealed; however they find means to ſell ſome at a very ſmall price to ſmugglers, for rum and tobacco. There are diamond mines in other provinces of Brazil, but not worked.

ART. XXX. *On General Works in Natural Hiſtory; and particularly on the Edition of Linnæus's Syſtema Naturæ, juſt publiſhed by M. I. F. Gmelin.* By J. B. LAMARCK.

THE very rapid progreſs of Natural Hiſtory in late years, has given riſe to a great number of works, containing new and particular obſervations, publiſhed in all parts of Europe; in which, for want of due communications among Naturaliſts, very conſiderable diſagreements are to be found with reſpect to names and deſignations. It is the proper buſineſs of a general ſyſtematic work to correct all theſe, and refer every object to its proper place in the ſyſtem. This is the avowed purpoſe of Gmelin's new edition of the *Syſtema Naturæ*; but according to the preſent writer, it is very imperfectly executed. The author ſeems to have compoſed his work, by adding to the Linnean genera and ſpecies, every article which he found given as new in certain works which he conſulted; without the neceſſary previous enquiries whether they were really ſo, or whether there did not exiſt other works on the ſame ſubjects. Mr. Lamarck has in a haſty peruſal of the botanical part detected a number of errors, which he enumerates under the following heads. 1. The ſame plant conſtituting ſeveral genera, or mentioned in ſeveral. 2. Several generas made from congenerous plants. 3. Species under double names in the ſame genus. For the particulars, we refer to the original thoſe who are curious to ſee them.

ART. XXXI. *Memoir on the Natural Hiſtory of the Air and Meteors of the Climate of Paris. By Father* COTTE.

IT is the purpoſe of this memoir to give a hiſtory of the meteorological changes of the atmoſphere in the climate of Paris, drawn from regiſters of obſervations.

I. *Of the weight of the air at Paris.* Barometrical obſervations have been made and recorded at different obſervatories in Paris from the year 1666 to the preſent; but as the inſtruments have undergone a change, and the elevations of the places of obſervation are different, the writer has found it neceſſary to calculate averages of the reſults, in order to form the following table of general averages for 125 years. It is to be obſerved, that the meaſures are according to the Paris ſcale.

Months.	*Greateſt height.*		*Leaſt height.*		*Medium height.*	
	In.	L.	In.	L.	In.	L.
January	28	6,3	27	3,9	28	0,1
February	28	5,9	27	3,9	28	0,1
March	28	4,5	27	5,1	27	11,6
April	28	4,7	27	5,6	27	11,11
May	28	4,	27	7,3	28	0,5
June	28	4,2	27	8,3	28	0,4
Firſt Half Year	28	6,3	27	3,9	28	0,1
July	28	4,1	27	8,1	28	1,2
Auguſt	28	4,4	27	8,1	28	1,4
September	28	4,8	27	7,3	28	0,4
October	28	4,3	27	8,6	28	0,7
November	28	5,2	27	4,4	27	11,7
December	28	5,5	27	3,7	27	11,9
Second Half Year	28	5,5	27	3,7	28	0,1
Year	28	6,3	27	3,7	28	0,1

Sometimes, but rarely, the barometer has been obſerved as high as 28..10, and as low as 26..8. It undergoes a periodical diurnal variation, being higheſt in the evening, loweſt at noon, and middle in the morning; but this change amounts only to ſome 12ths of a line.

Of the weight of the air at Montmorency. This place, the reſidence of the writer, is elevated 42 toiſes above the mid-level of the Seine at the Pont-Royal, and 60 toiſes above the ocean. The barometer there ſtands 3 lines lower than that at the Pont-Royal, and 1½ lower than at the Royal Obſervatory. The general reſult of 24 years of obſervations at Montmorency is as follows.

	Greateſt height.		*Leaſt height.*		*Middle height.*	
Firſt half year	28	3,9	27	1,6	27	9,1
Second half year	28	4,3	27	1,8	27	10,5
Year	28	4,3	27	1,6	27	10,1

The extent of the variations here is exactly the ſame as at Paris. In both, the greateſt changes happen in the winter months, and are chiefly effected by the direction and force of the wind. Of all the cauſes that act upon the barometer, the changes of the winds are by much the moſt efficacious.

II. *Of the temperature of the air at Paris.* On account of the variations in ſcale and conſtruction that the thermometer has undergone, Father Cotte rejects the older records of obſervations, and confines himſelf to thoſe of M. Meſſier. Of theſe, the reſult of 28 years, from 1763 to 1790, is given in the following table. The ſcale is Reamur's.

Month.	*Greateſt heat.*	*Leaſt heat.*	*Middle heat.*
January	8,9	-6,8	1,3
February	10,0	-3,4	4,1
March	12,5	-2,0	5.0.
April	16,6	1,1	8,4
May	22,3	5,3	13,0
June	24.6	9,1	15,2
Firſt half year	24,6	-6.8	8,0
By Fahrenh.'s ſcale	87,3	16,7	46,0

Month.	*Greateſt heat.*	*Leaſt heat.*	*Middle heat.*
July	25,0	11,2	16,4
Auguſt	25,9	11,5	17:4
September	21,8	7,0	13,4
October	16,0	3.3	9.5
November	12,8	-3,9	4:8
December	9,2	-5:3	2,2
Second half year	25,9	-5.3	10.6
By Fahrenh.	90,2	20,1	55,8
The whole year	25,9	-6,8	9 3
By Fahrenh.	90,2	16,7	52,9

At Montmorency, the general reſults of the writer's obſervations for 24 years, from 1768 to 1790, were,

	Greateſt.	*Leaſt.*	*Middle.*
Firſt half year	24,1	-7,0	7,0
Second half year	24,6	-5.7	9.8
Whole year	24,6	-7,0	8,4

III. *On the dryneſs and moiſture of the air at Paris.* It is ſo lately that Hygrometry has been brought to any degree of perfection, that the writer thinks it enough to give the reſults of the obſervations with this inſtrument at the Royal Obſervatory for three years. Greateſt average humidity, 104,7. Greateſt dryneſs, 53. Medium, 79,4. The greateſt dryneſs is uſually in March and April.

The quantity of rain falling has been meaſured at Paris for a long ſeries of years, and the following table gives the reſult.

	In.	L.		In.	L.
January	1	5,0	July	2	4.7
February	1	6,9	Auguſt	1	10.6
March	0	9.8	September	1	8,2
April	2	4,0	October	1	0,3
May	1	11,2	November	1	8,0
June	2	3:3	December	1	3:0
Firſt half year	10.	3,10	Second half year	9	10,6
			Whole year	20	2,4

The rains are more abundant, but leſs frequent, in the ſummer than the winter months. The following table gives the average number of days in which rain or ſnow fell, in each month.

January	11	May	14	September	12
February	13	June	16	October	13
March	13	July	15	November	14
April	13	Auguſt	10	December	15

Firſt half year, 80. Second half year — 79. Total — — 159

At *Montmorency*, the reſults of a ſeries of obſervations on the dryneſs and moiſture by a feather hygrometer, were,

	Greateſt Dryneſs.	Greateſt Moiſture.	Medium.
Firſt half year	50,4	1.3	23 7
Second half year	47:3	2,4	21,2
Whole year	50,4	1,3	22,4

The extreme of dryneſs took place in April; of moiſture in January. The medium annual quantity of rain was 19*inch.* 9,1*l.*; the medium number of rainy days was 126.

The ſollowing table gives the medium of evaporation from a veſſel containing 3 cubic inches of water, obſerved for 15 years.

	Inch.	L.		Inch.	L.
January	0	7.9	July	4	7:7
February	1	0,6	Auguſt	4	9,4
March	1	9,6	September	2	10.9
April	2	9.7	October	1	8,2
May	4	0.4	November	1	3.9
June	4	3.3	December	0	8,6
Firſt half year	14	6,11	Second half year	16	0.1
			Whole year	30	7,0

IV. *On the direction of the wind at Paris and Montmorency.* The following table was made from obſervations of a common weathercock.

	Paris.	*Montmor.*		*Paris.*	*Montmor.*
January	S.	S. W. and N.	July	W.	S. W. and N.
February	S. and S. W.	S. W.	Auguſt	S. W. and N.	S. W. and N.
March	N. E. and N.	N.	September	S. W.	S. W.
April	N. E. and N .	N. and N. E.	October	S. and S. W.	S. W. and S.
May	S. W. and W.	S. W. and N.	November	S.	S. W.
June	W.	N. E. and W.	December	and S. W.	S. W.

Tempeſts are rare in both places, not above 8 or 10 days in the year, and generally about the equinoxes and ſolſtices.

V. *On the electricity of the air in the climate of Paris.* From the obſervations of 15 years at Montmorency with an inſulated apparatus, the writer has drawn the following reſults.

1. The electric matter almoſt always becomes ſenſible in ſtorms, eſpecially preceded by great calms and ſtrong heat.

2. Simple appearances of ſtorms, ſuch as floating clouds carried from ſide to ſide by different winds, ſometimes ſuffice to render it apparent.

3. The inſtant of the manifeſtation of the electric matter in the greateſt abundance, is that of the appearance of lightning, and the reſolution of the cloud in rain; the bells are uſually ſilent during the thunder, and begin again at its ceſſation. If the ſhower continues, the electricity ceaſes; whence it ſeems to be the vehicle of the electric matter from the clouds to the ground.

4. The electric appearance is preceded by a calm, and followed by an impetuous wind and more copious rain.

5. The electricity is ſtronger, the drier the air is; there are, however, certain miſts which are accompanied by electricity, which are without doubt thoſe which contain more exhalations than vapours.

6. The conductor ſometimes ſhewed marks of electricity during the fall of hail, and even of ſnow in the ſpring; a ſimple ſhower-ſtorm without thunder often is ſufficient to electriſe the conductor.

VI. *Of ſtorms in the climate of Paris.* Lightning ſeldom falls here. It is in general preſerved from ſuch ſtrokes by natural conductors, ſuch as the river, the courſe of which thunder-ſtorms uſually follow, woods, foreſts, &c. The preſervative effect of theſe, the writer thinks infinitely ſuperior to that of artificial conductors, which he ſeems to conſider as mere play-things, totally diſproportioned to the object.

VII. *Of the appearance of the Aurora Borealis in the climate of Paris.* It is ſeen only in particular months, chiefly thoſe of March, April, September, and October. The medium annual number of its appearances are 11 or 12. With reſpect to the indications of weather to be taken from this phænomenon, obſervation teaches, 1. that fair weather more frequently than foul precedes the Aurora Borealis; 2. that cold predominates both before and after, more frequently than heat; 3. that it is more commonly followed, than preceded, by rain, ſnow, and fogs.

VIII. *Of the declination and variation of the magnetic needle in the climate of Paris.* The declination of the needle at Paris before 1666 was N. E. In that year it was null, and ſince has been N. W. continually augmenting to the preſent time. This augmentation, however, has of late years been annually diminiſhing. The preſent declination may be reckoned about 22 degrees. The inclination or dipping of the needle was in 1790 obſerved to be 70° 48′ 58″. It has alſo a diurnal variation, in which it moves *from* the north from eight in the morning to two in the afternoon, and back again the remainder of the twenty-four hours. It is likewiſe found to undergo extraordinary variations and agitations before, after, and during, the appearance of Aurora Borealis; ſo ſenſible, that the writer has often predicted this phænomenon from thoſe changes. They do not, however, accompany all Auroræ Boreales, nor the ſtrongeſt.

Such are the general reſults of the meteorological obſervations on the climate of Paris; from which it appears to be among the moſt temperate and agreeable of France. The Society of Natural Hiſtory have thought it proper to afford, by means of Father Cotte's Memoir, ſome fundamental ideas on the temperature of the diſtrict which is the center of their reſearches; but do not mean henceforth to engage in phyſical enquiries.

The remainder of the volume contains, *Catalogues of Plants, Mammifera, Birds, Inſects, and Shells, ſent to the Society from Cayenne by M. Le Blond.*

Notice of Remi Villemet. This perſon was born at Nancy in 1762, took his doctor's degree in phyſic in 1783, was appointed lecturer on botany in his native town, and was one of the firſt members of the Linnean Society. He afterwards went a voyage to the Eaſt Indies with Tippoo's ambaſſadors, and died at Seringapatam in 1790. He diſtinguiſhed himſelf by indefatigable ardour in the ſtudy of Natural Hiſtory, and a very methodical genius, which diſplayed itſelf in the commencement of ſome vaſt ſyſtematic plans, which death prevented him from completing.

Tranſactions of the Royal Iriſh Academy 1789, 4to.

Experiments on the Alkaline Subſtances uſed in Bleaching, and on the Colouring Matter of Linen Yarn. By Richard Kirwan, *Eſq; F.R.S. and M.R.I.A.*

Sect. I. IT having been obſerved that bleachers, although very expert in their art, are extremely ignorant of the agency of the inſtruments they employ, and that upon a late occaſion when the alkaline ſubſtances imported from abroad were very ſcarce, that it was ſeriouſly queſtioned by them, whether Ireland could be ſupplied by any materials manufactured at home, Dr. Kirwan undertook ſolely from motives of public utility to inform them of a ſure means of diſtinguiſhing the relative powers of every ſaline ſubſtance they may uſe, together with an account of the beſt method of obtaining them, as well as of adapting them to the purpoſe of bleaching.

Sect. II. *On Barilha.* The beſt kind is obtained from the aſhes of a plant deſcribed by Juſſien, in the Memoirs of the Academy of Paris for 1717, under the name of *Kali hiſpanicum, ſupinum annuum, ſedi foliis brevibus.*

One pound of this Barilha, which Mr. Kirwan analyſed by a very long and tedious proceſs, was found to contain as follows:

Fixed air - - - -	960	
Charcoal - - - -	861,82	
Calcareous earth - - -	542,86	1050,67
Muriatic earth - - -	127	
Argillaceous - - - -	131,23	
Siliceous - - - -	249,58	
Mineral alkali pure - - -	842	1219
Mineral ditto impure - - -	250	
Mineral ditto mixed with common ſalt -	127	
Glauber's ſalt - - - -	125	
Common ſalt - - - -	70	
Earth depoſited - - -	20	
	4306,49	
Water - -	1453,51	
Total - -	5760,00	

Of the 960 grains of fixed air, only 201 were contained in the ſaline part, the reſt being united to the earthy one; and hence bleachers ought not to uſe boiling water to extract the ſaline part, for that being almoſt in a cauſtic ſtate, diſſolves the coaly matter which ſullies the ſolution, and is afterwards depoſited on the linen from which it cannot afterwards be ſeparated.

Sect. III. *On Dantzic Pearl Aſh.* One pound of this Mr. Kirwan found to contain,

	Grains.	
Fixed air - - - - -	1290	
Moiſture - - - - -	414	
Tartare vitriolate - - - -	505	
Digeſtive ſalt and ditto - - -	36	
Earth - - - - -	38	
	2283	5760
Mere alkali - - - - -	3477	−2283
	5760	3477

Sect. IV. The quantity of alkali in any ſaline ſubſtance being all that is neceſſary to be known by bleachers, and Mr. Kirwan being diſguſted by the tedioufneſs of the former analyſes, he bethought himſelf of an eaſy practical method for aſcertaining this.

1ſt. Procure a quantity of alum, ſuppoſe one pound, reduce it to powder, waſh it with cold water, and then put it into a tea-pot, pour on it three or four times its weight of boiling water.

2dly. Weigh an ounce of the aſh or alkaline ſubſtance to be tried, powder it and put it into a Florence flaſk with one pound of pure water, (common water boiled for a quarter of an hour, and afterwards filtered through paper, will anſwer) if the ſubſtance to be examined be of the nature of barilha or pot-aſh; or half a pound of water if it contain but little earthy matter, as pearl-aſh; let them boil for a quarter of an hour, when cool let the ſolution be filtered into another Florence flaſk.

3dly. This being done, gradually pour the ſolution of alum hot into the alkaline ſolution alſo heated; a precipitation will immediately appear; ſhake them well together, and let the effervescence, if any, ceaſe before more of the aluminous ſolution be added; continue the addition of the alum until the mixed liquor, when clear, turns ſyrup of violets or paper tinged blue by raddiſhes, or by litmus, red; then pour the liquor and precipitate on a paper filter placed in a glaſs funnel, the precipitated earth will remain on the filter; pour on this a pound or more of hot water gradually until it paſſes taſteleſs; take up the filter and let the earth dry in it until they ſeparate eaſily, then put the earth into a cup of Staffordſhire ware, place it on hot ſand and dry the earth until is ceaſes to ſtick to glaſs or iron, then pound it and reduce it to powder in the cup with a glaſs peſtle, and keep it a quarter of an hour in a heat of from 470° to 500°.

4thly. The earth being thus dried, throw it into a Florence flaſk and weigh it, then put about one ounce of ſpirit of ſalt into another flaſk, and place this in the ſame ſcale as the earth, and counterbalance both in the oppoſite ſcale: This being done, pour the ſpirit of ſalt gradually into the flaſk that contains the earth, and when all effervescence is over, (if there be any) blow into the flaſk, and obſerve what weight muſt be added to the ſcale containing the flaſks to reſtore the equilibrium; ſubtract this weight from that of the earth, the remainder is a weight exactly *proportioned* to the weight of mere alkali of that particular ſpecies which is contained in one ounce of the ſubſtance examined; all beſides is ſuperfluous matter.

In this manner alkalies of the *ſame ſpecies* may be directly compared, ſince alkalies of *different* ſpecies require the intervention of another proportion, becauſe equal quantities of alkalies of different ſpecies precipitate unequal quantities of earth of alum.

The application of this teſt is founded on the following principles:

1ſt. That a hot ſolution of a free alkali, or of an alkali combined only with fixed air or ſulphur, can hold no *terreno* or *metallico neutral* ſalt in ſolution; though it may *alkalino neutral* ſalts or quick lime, if the alkali be free from fixed air.

2dly. That earth of alum cannot be precipitated either totally or partially by the hot ſolutions of any *alkalino neutral* ſalt, and therefore that its precipitation is always due to the preſence of a free alkali, or at leaſt of an alkali combined only with fixed air or ſulphur, to whoſe quantity it is always proportional. It is true quick lime will alſo decompoſe alum, but the preſence of quick lime is eaſily diſcovered by the addition of a few drops of any mild alkaline ſolution, and by the ſame means as eaſily ſeparated.

3dly. That if the earth of alum takes up fixed air, (which would increaſe its weight) this air will be ſeparated by the heat employed in drying it, or at leaſt by the ſpirit of ſalt poured upon it, and ſo may alſo another heterogeneity which will hereafter be mentioned.

There is but one inaccuracy attending this teſt, which however is of little moment, namely, that if the alkali contains ſulphur, it will be precipitated with the earth of alum. But in common caſes this ſcarcely amounts to 2 or 3 grains.

That the abſolute weight of alkali in different alkaline ſubſtances, or aſhes may be found by this teſt, appears by the following experiments.

SECT. V. *Cryſtallized Soda* contains only $\frac{1}{5}$ of its own weight of alkali, the reſt being water and fixed air. Mr. Kirwan found that 480 grains of mere alkali would precipitate 725 grains of earth of alum.

Sweet Barilha. The ſolution of one ounce of barilha precipitated 174 grains of earth of alum; therefore, ſince 725 grains of earth of alum require for their precipitation 480 of mere mineral alkali, 174 grains of that earth require 115,2 of mere mineral alkali. And conſequently one ounce of barilha contains but 115,2 of mere alkali; and one pound of barilha ſhould contain 1382,4 grains.

Cunnamara Kelp. This is a hard black porous ſubſtance, mixed with white and grey ſpots, ſmells ſulphureous, and taſtes of a mixture of common ſalt and alkali.

An ounce of it being diſſolved in marine acid, loſt 24 grains of its weight, which was hepatic air. Another ounce being diſſolved in water left an inſoluble reſidue weighing 165, and which was chiefly calcareous. This ſolution precipitated 25 grains of earth of alum, and therefore contained 16,5 grains of mere alkali.

Each ounce of this kelp contains beſides 4 grains of ſulphur.

Strangford Kelp. An ounce of this precipitated only 4 grains of earth of alum, and left an inſoluble reſiduum of 174 grains.

Vegetable Alkali. 480 grains of the pureſt and drieſt precipitated 331,5 grains of earth of alum.

Dantzic Pearl Aſh. The ſolution of an ounce of this precipitated about 210 grains of earth of alum.

Caſhop contains about 93 grains per ounce of vegetable alkali.

Mr. Clarke's refined Aſh contains only 129 grains of mere vegetable alkali, the remainder being chiefly on inſoluble earth and neutral ſalts.

Common Iriſh Weed Aſhes. An ounce of this well dried was found to contain 136 grains of ſaline matter; but of this ſaline matter only 22,4 grains were pure alkali.

SECT. VI. *Of the method of procuring Mineral Alkali.*

1. This is procured more or leſs pure from the combuſtion of various ſpecies of kali, or from that of the different ſpecies of Salicornia and Chænopodia.

The cultivation of the Salicornia is deſcribed in the 5th vol. of the *Mem. des Scavants Etrangers.* A French acre produces one tun of this weed, and this tun when burned produces but 100 weight.

2. It is found native in Ruſſia and Ægypt, and may therefore be probably cheaply imported.

3. Common ſalt may be decompoſed by triturating it with lytharge, after Mr. Turner's method. Mr. Kirwan has alſo contrived a proceſs for decompoſing this ſalt.

1ſt. "I rendered the common ſalt pure by adding to its ſolution a ſolution of mineral alkali until all the earthy matter was depoſited.

2dly. To a ſolution of three ounces of this purified ſalt in nine ounces of water I gradually added a ſaturate ſolution of 4,75 ounces of ſugar of lead, both hot, until the ſolution of lead ſcarce excited any whiteneſs in that of the common ſalt. After one night's reſt part of the ſugar of lead cryſtallized in the bottom of the veſſel, by which it is plain that too much of it had been uſed. Theſe cryſtals weighed 240 grains; the ſupernatent liquor I again evaporated to nearly $\frac{2}{3}$, and after two days obtained large pellicles of acetous ſoda, which I ſeparated; they weighed 325 grains; to the reſiduum, which ſtill had a ſweetiſh taſte, I added a ſolution of mineral alkali, until no further precipitation appeared; a very ſmall quantity of the alkali was ſufficient for this purpoſe. I then evaporated the remainder nearly to dryneſs; and afterwards heated it in a crucible to redneſs: In this heat it inflamed, and when calcined nearly to whiteneſs, I took it out and diſſolved it in twelve ounces of water, filtered it, and on adding an hot ſolution of alum obtained a precipitate, which when dried weighed 169 grains, and indicated the quantity of pure alkali to be 112 grains nearly. In this proceſs nothing is loſt, for the lead may be either revived or turned into a pigment."

Of the Vegetable Alkali. It is now known that this ſubſtance exiſts in vegetables, combined ſometimes with the vitriolic and marine acid, but generally, and for the greater part with a vegetable acid or oil, with which it forms eſſential ſalt. Theſe acids and oils are decompoſed during combuſtion, and the alkaline ſalt ſet free, "but "the vitriolic acid by contact with inflammable matter is converted into ſulphur, "part of which unites to the free alkali, which protects it from combuſtion, and thus "forms what is called liver of ſulphur, a product found in moſt aſhes, eſpecially when "the air has not had free acceſs to them during combuſtion."

From comparing the ſaline products of a number of vegetable ſubſtances, it would appear that in general, weeds yield much more aſhes, and their aſhes more ſalts than woods, and that therefore, in regard to the vegetable alkali, neither America, Trieſte, or the Northern Countries poſſeſs any advantage over Ireland.

SECT. VII. *Of the Proceſs for obtaining Pot and Pearl Aſh.*

1ſt. "The weeds ſhould be cut juſt before they ſeed, then ſpread, well dried, and gathered clean.

2dly. They ſhould be burnt within doors on a grate, and the aſhes laid in a cheſt as faſt as they are produced. If any charcoal be viſible it ſhould be picked out and thrown back into the fire. If the weeds are moiſt much coal will be found. A cloſe ſmothered fire, which has been recommended by ſome, is very prejudicial.

3dly. They ſhould be lixiviated with twelve times their weight of boiling water. A drop of the ſolution of ſublimate corroſive will immediately diſcover when the water ceaſes to take up any more alkali. The earthy matter that remains is ſaid to be a good manure for clayey grounds.

4thly. The ley thus formed ſhould be evaporated to dryneſs in iron pans; two or three at leaſt of theſe ſhould be uſed, and the ley as faſt as it is concentrated paſſed from one to the other; thus much time is ſaved, as weak leys evaporate more quickly than the ſtronger. The ſalt thus procured is of a dark colour, and contains much extractive matter, and being formed in iron pots is called *pot aſh*.

5thly. This ſalt ſhould then be carried to a reverberatory furnace, in which the extractive matter is burned off and much of the water diſſipated; hence it generally loſes from 10 to 15 per cent. of its weight. Particular care ſhould be taken that it ſhould not melt, as the extractive matter would not be thoroughly conſumed, and the alkali would form ſuch a union with the earthy parts as could not eaſily be diſſolved. I added this caution, as Doctor Lewis and Mr. Doſſie have inadvertently directed the contrary. This ſalt thus refined is called pearl aſh, and muſt be the ſame as Dantzic pearl aſh."

Sect. VIII. Mr. Kirwan obtained a quantity of the alkaline ley ſaturated with the colouring matter, and to five quarts of it added two ounces of weak marine acid. No efferveſcence took place, but there was an inſtantaneous precipitation of the colouring matter. This matter Mr. Kirwan afterwards diſcovered by means of a ſeries of well planned experiments, to be a peculiar kind of reſinous matter, reſembling lack in this that it is not ſoluble in eſſential oils.

It is ſoluble in all the alkalies, but in different proportion.

Liver of ſulphur is the moſt powerful ſolvent of this matter, next to that the cauſtic vegetable alkali, and after this the cauſtic mineral alkali, then the mild vegetable alkali, and laſtly, the mild mineral alkali.

Clarke's ſalt converted into liver of ſulphur, is preferable to kelp, ſince the latter as commonly prepared contains charcoal, which it afterwards depoſits in the yarn, leaving a black tinge. Hence it follows that the linen manufacture ſtands in no need of foreign ſalt or aſhes for the purpoſes of bleaching.

Letter from Richard Kirwan, Eſq. F.R.S. and M.R.I.A. to the Right Honourable the Earl of Charlemont, P.R.I.A.

THIS letter encloſes one from Mr. Mills, an eminent miner of Cheſhire, to Mr. Kirwan, the tendency of which is to reſtrict the generality of an obſervation made by Mr. Kirwan on the coal mines of Newcaſtle and Newhaven, which he had unwarily extended to all the coal mines in England.

Mr. Kirwan's obſervation was, that "In England beds of coal of leſs than two feet and a half in thickneſs, are judged not worth working."

Mr. Mills aſſures Mr. Kirwan, that at Blakelow colliery, near Macclesfield, much thinner ſeams and at conſiderable depths, as is apparent from the ſubjoined table of ſtrata.

	Feet.	Inches.	
No. 1.	15	0	Clay and gravel.
2.	102	0	Black argillaceous ſhale.
3.	00	1	Smut ſeam of coal.
4.	25	6	Rock. A pale grey fined-grained ſiliceous gritſtone, containing much particles of mica.
5.	2	3	Grey beds. A ſoft, lanunated, pale grey gritſtone, containing mica between the lamina.
6.	00	4	Shale.
7.	1	6	Grey beds.
8.	1	6	Shale.
9.	00	9	Grey beds.
10.	2	3	Shale.
11.	1	2	Middle ſeam of a good quality.
12.	00	9	Cap. Grey clay.
13.	36	0	Rock. A compact fine-grained, brown, ſiliceous grit-ſtone, containing ſmall particles of mica.
14.	3	0	Grey beds.
15.	00	4	Shale.

No.

	Feet.	Inches.	
No. 16.	2	3	Grey beds.
17.	1	0	Shale.
18.	1	6	Grey beds.
19.	2	3	Shale.
20.	00	4	Nodules of iron ſtone or ſhale.
21.	2	3	Shale.
22.	1	4	Gank, or principal ſeam of coal of a good quality. *Note,* Higher on the riſe this ſeam has been proved 22 inches thick.
23.	1	9	Cap. Grey clay.
24.	30	0	A medley of grey beds and ſhale, blended together without any regularity.
25.	1	4	Harper ſeam. A very ordinary coal, full of pyrites, and not worked. *Note,* The beds dip N.E. and riſe S.W. one yard in three yards and an half.

The Origin and Theory of the Gothic Arch. By the Rev. M. Young, *D.D. &c.*

THE Saxon, Norman, and Gothic ſtyles of architecture are firſt compared together, and from the compariſon it is concluded, that the Saxon bears ſome ſimilitude as it were to the Tuſcan order, the Norman to the Doric and Ionic, and the Gothic to the Corinthian and Compoſite.

There are five opinions on the origin of the Gothic architecture. 1. That it was introduced from the Eaſt by the Cruſaders, and ſhould therefore be called Saracenic, but this opinion cannot be ſupported, becauſe there are inſtances of this ſpecies of architecture, as Croyland bridge, in Lincolnſhire, prior to the Cruſades, and it does not appear that the Gothic is the prevailing ſtyle of architecture in the Eaſt. 2. That it is borrowed from the Moors in Spain, and ſhould therefore be called Mooreſque; but it appears from Swinburn's travels in Spain, and the drawings of the Mooriſh palaces in les delices d'Eſpagne, that the form and decorations of the Mooriſh arch are very different from thoſe of the Gothic. 3. That it was derived from the ancient cuſtom of worſhipping in groves, which are imitated in this ſpecies of architecture. But, if this were the caſe, the moſt ancient buildings would have been Gothic, which is contradicted by fact; and if it were adopted for religious buildings, this could be no reaſon for its admiſſion into military architecture. Its uſe in the latter muſt have taken its riſe from a ſuppoſition of ſuperior ſtrength, beauty, or other peculiar advantages. 4. That the Gothic arch originated from the interſection of circular arches in Saxon architecture. But if ſo, the Gothic architecture would have had a Saxon original, and yet we find it in countries, where no other traces of the Saxon ſtyle occur. 5. That it originated from the like interſection of circular arches in Grecian architecture. The Saxon, Gothic, Mooriſh, and Eaſtern ſtyles of building, are evidently various corruptions of the Grecian; but it by no means appears, that the Gothic arch derived its origin from the identical circumſtance in Grecian architecture here pointed out. Barry ſuppoſes ſucceſſive corruptions of architecture, by which it was led inſenſibly from the Grecian to the Gothic ſtate, and obſerves, that "there "are at the dome of Viterbo and at St. Mark's, Venice, ranges of columns, from

" which regular arches, of half a circle, interſect one another, by being made to " ſpring from every third column, which gives a Gothic arch between every two." But St. Mark's, according to the teſtimony of Vaſari, was built towards the concluſion, not the commencement of the period of corrupt architecture. So that if the pointed arch was indeed ſuggeſted in this manner, which however is extremely uncertain, it muſt rather have been derived from the church of St. Sophia at Conſtantinople, built in the year 344, from which the plan of St. Mark's was taken.

In truth, it ſeems fruitleſs to enquire into the ſpecific accident which gave birth to the pointed arch. Our ſpeculations may be entertaining on the poſſible cauſes which gave riſe to it; but we can be ſaid to reaſon only, when we direct our enquiries into the actual properties of the arch, which might have recommended it after the faſhion of ſuch an arch had been conceived. I ſhall therefore proceed to enquire into the theory of this arch, to aſcertain its relative ſtrength, as compared with circular and elliptic arches, when in a ſtate of perfect equilibrium, and to determine the aberration from a true balance which is generated by the horizontal termination of the ſolid building erected on it.

The equilibration of arches may be aſcertained by conſidering the vouſſoirs or arch ſtones, as ſo many wedges urged by the incumbent weight, and endeavouring to ſplit the arch. The force, therefore, of a vouſſoir depending on the magnitude of the vertical angle, the impelling force, and the reſiſtance to be overcome, is on the firſt account directly as the radius of curvature of the arch at that point, on the ſecond as the ſquare of the ſine of the angle formed by the tangent to the curve at the given point, with a vertical line, and on the third as the ſine of the ſame angle.

1. Let EABF, *r m n t*, (Plate XVI. Fig. 5.) be two concentrical ſemicircles, and AB, *m n*, two vouſſoirs ſimilarly ſituated, whoſe ſides perpendicular to the curves converge to the center C. The forces of theſe vouſſoirs conſidered as wedges, are inverſely as the ſeries of their vertical angles, or becauſe of the equality of the arches directly as the radii of curvature.

2. Let H *h* be the invariable breadth of the vouſſoirs, G *g* H *h* the incumbent weight, which, ſince G H is ſuppoſed given, is as the breadth *h k*, or as the ſine of the angle *h* H *k*, by the reſolution of force into two *g* K, H K, the latter is the force impelling the vouſſoir to ſplit the arch, which ſince *g* H is given, varies as the ſine of H *g k*, or *h* H *k*. ∴ The force impelling the vouſſoir is as the ſquare of the ſine of *h* H *k*.

3. The wedge impelled in a direction perpendicular to the curve endeavours to ſplit the arch, and therefore move one ſegment about the fulcrum *r*, and the other about the fulcrum *t*. ∴ The force of the vouſſoir acting on the levers H *t*, H *r* is as the perpendicular *t p*, *r q*, or as the ſerie of the angle *t* C *p*, or *h* H *k*.

Hence if the height of the wall incumbent on EABF is inverſely as the cube of *h* H *k* × rad. of curvature in that point, the vouſſoirs will endeavour to ſplit the arch with equal forces, and will be in perfect equilibrium with each other.

To find the comparative ſtrength of arches of different ſpans. Let BD (Plate XVI. Fig. 6.) be the ſpan of the Gothic arch BGD, the center of the arch DE being C. On BD deſcribe the ſemicircle BHD, the ſtrength of the ſemicircular arch BHD at H is to that of the ſemicircular arch AGD at G as CD to KD. But, as the relative ſtrength of arches is to be determined by comparing them in their weakeſt points, the ſtrength of AGD is to that of the Gothic arch BED, as the ſtrength at G is to the ſtrength at E, that is, as the greateſt weights theſe points can bear in equilibrio, as the cube of the ſine of IEF or ECK, or EK^3 to rad. o^3. $\therefore$ The ſtrength of BHD is to the ſtrength of BED :: $GC \times EK^3 : KD \times GC^3$ :: $EK \times AK : CD^2$.

Let $CD = a$, $CK = x$ $\therefore EK = \sqrt{a^2-x^2}$ and $AK = a+x \therefore EK \times AK = \sqrt{a^2-x^2}$ $\times \overline{a+x} = a$ maximum. $\therefore \sqrt{a^2-x^2}.\ \dot{x} - \frac{x^2\dot{x} - ax\dot{x}}{\sqrt{a^2-x^2}} = 0.$ $\therefore x^2 + \frac{1}{2}ax = \frac{1}{2}a^2 \therefore x$ $= \frac{1}{2}a$. The ratio of the ſtrength of a ſemicircular to a Gothic arch is greateſt, when the ſubtenſe of half the Gothic arch is equal to its ſpan, and in this caſe the ſtrength of the former is to that of the latter :: 1299 : 1000 :: 13 : 10 nearly.

To find when the Gothic and ſemicircular arches of equal ſpan are of equal ſtrength, let $EK \times AK = CD^2$. $\therefore \overline{a+x} \times \sqrt{a^2-x^2} = a^2 \therefore x^4 + 2ax^3 - 2a^3x = 0$. If $a = 1$. $x^3 + 2x^2 = 2$. and x or CK = ,839286755214. $\therefore$ The radius of the Gothic arch is to the interval of the capitals from which it ſprings as 1 : ,321426489572.

In the depreſſed Gothic arch (Plate XVI. Fig. 7.) BFD is deſcribed from the centers m n lying below the horizontal line BD. Continue the arch FD to RS paſſing through m n, and then as before, the ſtrength of BFD is to the ſtrength of a ſemicircular arch of equal ſpan as $FG^3 \times KD : mS^4$, that is, always in a ratio of leſs inequality. And the ſtrength of the two Gothic arches BED, BFD varies as the ſquare of their radii of curvature directly, and the cube of the perpendicular height of the arches above the lines of their centers inverſely.

Suppoſing the arches not to be curves of equilibration, let BNED, BHD (Plate XVI. Fig. 8.) be the Gothic and ſemicircular arches, whoſe common ſpan is BD, and GR the extradoſſo of either, and GM the perpendicular meeting the curves in N and n, and a the altitude of the ſolid building erected on each. If the Gothic arch were in perfect equilibrium, the height above N would be to a as $EK^3 : NM^3$, and the height above n to the ſame a as HK^3 to nM^3. Deſcribe Bm ED an ellipſe with BD as a minor axis, and GK as a ſemitranſverſe, and the Gothic arch will be within it, $\therefore$ the ratio of EK to NM is greater than that of EK to mM, or of HK to nM. Therefore the height of the ſolid wall over N muſt be greater than that over n, and when the line bounding the wall is not the extradoſſo of equilibrium but an horizontal line, there will be a greater deviation from a perfect balance in the Gothic arch. The higher the Gothic arch, the leſs will be the aberration; and it may at length become leſs than the error in the ſemicircle, for the ordinates EK, NM, vary in the ſubduplicate ratio of their greater abſciſſæ, and theſe when MK is given approach towards equality, as the radius of the circle or height of the arch increaſes, but the ratio of HK to nM is the limit of their variable ratio, ſo that the height of the building to be erected on the points of the Gothic arch will aways be greater than in the ſemicircle. Since Ep is always greater than Er, and mM : EK is in the conſtant ratio of nM : HK by producing mM, EK, their difference Er may be made greater than any aſſignable quantity, and the difference between the heights of the building to be erected on the points Nn of the Gothic and ſemicircular arch may be made leſs than any aſſignable quantity. The defect therefore of the equilibrium over the point N in the Gothic arch may be made leſs than the defect over the correſponding point n of the ſemicircle, ariſing from the horizontal termination of the building erected on them. Let the difference of the heights of the

the wall over n and N, when the arches are in equilibrium, be equal to d and $Hv : Hv + d :: HK : KE$, then $Hv = Er - d$. Then a being the altitude over the crown of both arches, and Ng the height over n in the ſemicircle when truly balanced, the defect of equilibrium in the Gothic arch is $Ng + d - a - Ep$, and in the ſemicircle $Ng - a - Hv = Ng + d - a - Er$, but Ep is greater than Er, therefore the defect of equilibrium in the Gothic arch is leſs than in the ſemicircle; and, when the height of the building above the ſpring of the arch is given, the higher the arch the more it approaches to a perfect balance.

Hence this arch was well adapted to the religious buildings of the middle ages, where the roof was to be raiſed to an extraordinary height. But when a very high building is to be erected on a Gothic arch, the quantity of matter over the vertex muſt be lightened with windows or other perforations, as was uſual in theſe buildings.

The ſtrength of an ellipſe in equilibrio deſcribed on the ſpan of a ſemicircular arch is to that of a ſemicircular arch inverſely as the radii of curvature at the key-ſtones, thus the ſtrength of BmGD is that of BHD :: EK : KD, but the ſtrength of BHD is to that of the Gothic BGD :: $EK \times AK : CD^2$ ∴ the ſtrength of BmGD is to that of BED :: $EK^2 \times AK$ or $AK^2 \times KD : CD^2 \times KD :: AK^2 : CD^2$ in a ratio of greater inequality. Since KD is conſtant, AK increaſes in a higher proportion than CD, therefore in the elliptic arch the ſtrength increaſes in a higher proportion as the altitude increaſes than in the Gothic.

To determine the extradoſſo of an elliptic arch BGD (Plate XVI. Fig. 9.), through N draw the tangent NO meeting the axis produced in V, and on it let fall from the center A the perpendicular KA, and draw KC the ſemiconjugate to KN, and NT the ordinate to the axis. Let $BK = c$, $KE = t$, $ET = x$, $KA = p$, $KC = g$, $\therefore KV = \frac{t^2}{t-x}$ and $KA = \frac{tc}{g} \therefore \frac{t^2}{t-x} : \frac{tc}{g} :: 1 :$ Sine of KVN or MNA $= \frac{c \times \overline{t-x}}{tg}$ and its cube $= c^3 \times \overline{\frac{t-x}{tg}}^3$ but R the radius of curvature at N $= \frac{g^2}{p} = \frac{g^3}{tc}$ $\therefore R \times \overline{\text{Sine MNA}}^3 = c^2 \times \frac{\overline{t-x}^3}{t^4}$ and the height of the wall above N being inverſely as $R \times \overline{\text{Sine MNA}}^3$ is directly as $\frac{t^4}{c^2 \times \overline{t-x}^3}$ ∴ Height of the wall above N is to the height above E :: $\frac{t^4}{c^2 \times \overline{t-x}^3} : \frac{t}{c^2} :: t^3 : \overline{t-x}^3 :: \overline{KE}^3 : \overline{NM}^3 :: \overline{HK}^3 : n\text{M}^3$. ∴ The heights of the wall above each point N of the ellipſe and the correſponding point n of the ſemicircle are equal. Hence when the altitude over the vertex is given, and the termination of the wall horizontal, there will be a leſs deviation from a true balance in the higher arch, that is, the ellipſe. The height over N : a :: $\text{EK}^3 : \text{NM}^3$ and therefore $= \times \frac{\text{EK}^3}{\text{NM}^3}$ the height over $n = a \times \frac{\text{EK}^3}{m\text{M}^3}$ and the difference $= a \times \text{EK}^3 \times \frac{m\text{M} - \text{NM}^3}{\text{NM}^3 \times m\text{M}^3}$ which is greater than $a \times \text{EK} \times \frac{m\text{M} - \text{NM}}{\text{NM} \times m\text{M}}$ or $a \times \text{EK} \times \frac{\text{NM}}{\text{NM}^2}$ or than NM the difference of the ordinates, and therefore there will be a leſs deviation from a true balance in the elliptical arch than in the Gothic.

Hence an elliptic arch, whoſe tranſverſe axis is perpendicular to the horizon, is to be preferred to the Gothic arch for ſtrength, becauſe its ſtrength exceeds that of a Gothic arch of equal ſpan and altitude when both are in a ſtate of equilibration, and a given altitude of building raiſed upon it, and terminated by an horizontal line, produces a leſs aberration from a perfect balance of the parts. For the ſame reaſons the Gothic arch, when carried up to a ſufficient height, is to be preferred to one ſemicircular.

An Account of a Diſeaſe which, until lately, proved fatal to a great Number of Infants in the Lying-in Hoſpital of Dublin, with Obſervations on its Cauſes and Prevention. By JOSEPH CLARKE, *M.D. Maſter of the Hoſpital above-mentioned, and M.R.I.A.*

AT the concluſion of the year 1782, of ſeventeen thouſand ſix hundred and fifty infants born alive in the Lying-in Hoſpital of this city, two thouſand nine hundred and forty-four had died within the firſt fortnight, that is nearly every ſixth child, or about ſeventeen in the hundred. This was obviouſly a large proportion of deaths, as ſhall be proved more particularly hereafter. The diſeaſe which carried off moſt of theſe children, perhaps nineteen of twenty, was general convulſions, or what the nurſes have been long in the habit of calling the nine-day fits, owing to their conſtantly occurring within the firſt nine days after birth. As this diſeaſe has hitherto yielded to no remedy, Dr. Clarke has been always more engaged in attending to its prevention than cure. Dr. Clarke is chiefly indebted for its hiſtory, to the united reports of ſeveral of the moſt experienced *nurſe-tenders.*

This diſeaſe generally attacks with violent general convulſions, particularly affecting the extremities and face, and occurring at uncertain intervals. The agitation is in ſome very great, the mouth foams, the thumbs drawn into the palms of the hands, the jaws quite locked, and any attempt to wet the mouth or fauces, or to adminiſters medicines, ſeems to render the complaint infinitely worſe. The face and body ſwell and turn of a livid hue, which circumſtance when it occurs has given occaſion to the nurſes and attendants calling the complaint the *black fits.* The paroxyſm laſts from eight to thirty hours.

It happens more frequently that the ſymptoms are all leſs violent, the extremities being rather twiſted than convulſed, and the power of ſucking and ſwallowing remaining until near death.

As in theſe caſes the livid colour does not occur, but that on the contrary, the body ſhrinks and grows pale, becoming in ſhort a miſerable ſpectre of emaciation and diſeaſe, the nurſes have called theſe the *white fits.*

Both varieties *conſtantly* attack within nine days from the birth, and moſt frequently about the falling off of the umbilical chord. Diarrhœa is a conſtant concomitant of both ſpecies, and there is no example of either of them having ever been cured.

After maturely conſidering all circumſtances which ſeemed likely to cauſe this great mortality, and comparing in his own mind the conſtruction of the Dublin Hoſpital, and the care taken of the children with that of other hoſpitals, which he had ſeen, Dr. Clarke conjectured that this diſeaſe was owing to the following cauſes.

1ſt. " Foul air.

2d. " Neglect of keeping the children clean and dry.

3d. " Irregularity in the manner of living of their mothers, more eſpecially in " the abuſe of ſpirituous liquors."

" Viewing the ſubject in this light ſays Dr. Clarke, I propoſed a number of alterations intended for the more complete ventilation of the hoſpital, and for which I was principally indebted to Mr. White's excellent work on the management of lying-in women. My obſervations had the effect I wiſhed with Dr. Hutcheſon and the medical governors. Apertures of a conſiderable ſize were made in the ceilings of each ward, which have been ſince changed for air-pipes of ſix inches diameter. Three holes, of an inch diameter, were bored, in an oblique direction, through each window-frame at top. The upper part of the doors, opening into the gallery, were alſo perforated with a great number of holes. By theſe means a free and eaſy paſſage was given to the air through the wards at all times, and executed in ſuch a manner as to put it out of the power of nurſe-tenders or patients to controul. Since the above period alſo the number of beds in the large wards have been reduced to ſeven, and ſeveral changes made in their conſtructions, which render them more airy, and more eaſily kept clean. The conſequences have been favourable far beyond the expectation of every perſon concerned. The *nine-day* fits are become viſibly leſs frequent; and the abſtract of our regiſtry ſhews the fact at firſt view to the moſt inattentive obſerver. Of eight thouſand and thirty-three children born *ſince* the above *period*, only four hundred and nineteen have died in the hoſpital; that is nearly one in nineteen and a third, or from five to ſix in the hundred. Had the mortality of infants been in this proportion ſince the commencement of the Dublin hoſpital, the number of children dead would have been ſomewhat about thirteen hundred, inſtead of the preſent number, three thouſand three hundred and ſixty-three; or in other words, above two thouſand lives would have been ſaved to the community."

Dr. Clarke was for a long time at a loſs to explain the reaſon why the children ſhould be more affected by this impurity of air than the mothers, till he recollected from the experiments of Dr. Bryan Robinſon, that in children the maſs of blood is larger in proportion to the general bulk, than in adults. He concludes therefore that a greater proportion of phlogiſton is carried off from their lungs during reſpiration, than in adults, and that if this is checked, it muſt be proportionally more dangerous.

Dr. Clarke claſſes the diſeaſe under the genus Eclampſia, and calls it *eclampſia ab atmoſphera phlogiſticata.*

Dr. Clarke then compares ſimilar diſeaſes deſcribed by other authors, with the one mentioned, and from the whole concludes with the following obſervations:

1. That one effect of an impure atmoſphere, on the human body, is to produce ſpaſms and convulſions.

2. That all young creatures, and eſpecially infants within *nine* days after birth, ſuffer moſt ſeverely by ſuch a noxious cauſe; and therefore,

3. That in the *conſtruction* of lying-in hoſpitals, and perhaps of all public buildings intended for the reception of children, lofty ceilings, large windows and moderate ſized rooms ſhould be eſpecially attended to.

4. That in the *arrangement* of ſuch edifices, no apartment ſhould be completely filled with beds, if it can be conveniently avoided; and

5. That in their *management* attention is eſpecially neceſſary to *cleanlineſs*, as well as to the *conſtant* and *uniform* admiſſion of atmoſpheric air by *night* as well as by day; and

Laſtly. That by purſuing ſuch meaſures with care, diſeaſes may be *prevented* which it has *hitherto* been found *difficult*, and ſometimes *impoſſible, to cure.*

Deſcription

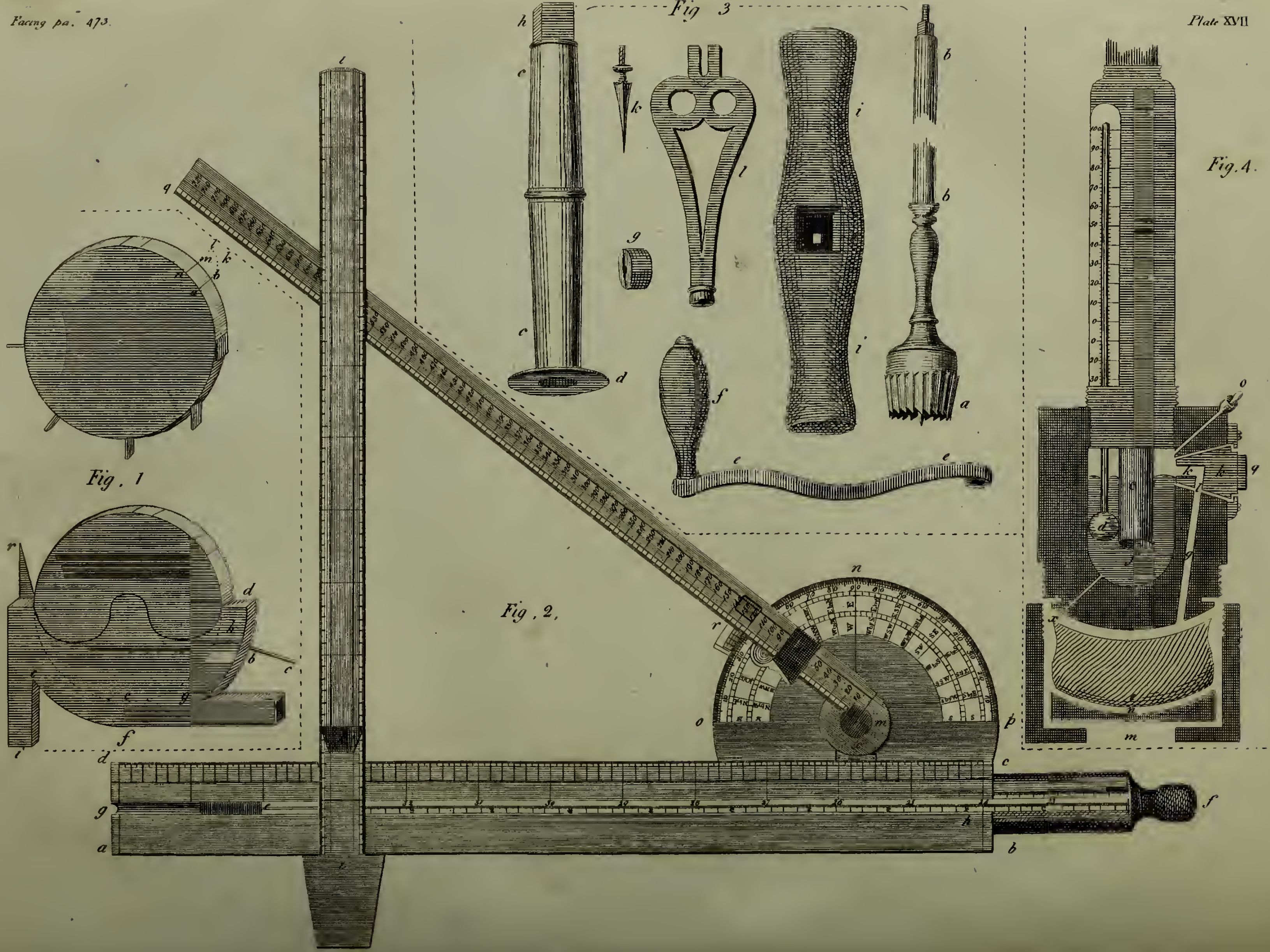
Fig. 1
Fig. 2.
Fig 3
Fig. 4.
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Deſcription of a Steam Engine. *By* J. Cooke, *Eſq. M.R.I.A.*

THIS machine, intended to produce a continuous and rotatory motion, conſiſts of three principal parts, the wheel, the caſe, and the condenſer; the laſt the ſame as in Watts's engine. The wheel has a broad flat ſmooth edge, *a b*, (Plate XVII. Fig. 1.) and at equal diſtances eight folding clacks or valves; when ſhut, ranging exactly with the ſurface of the edge of the wheel, and opening only half way. Thus the valve *anmb*, has a joint at *nm*, permitting it to open through the arch *bkl*, as far as *lm*, but no farther. In revolving, the valves fall open when they deſcend near the level of the axis, and when they aſcend above it, they ſhut by their own gravity.

The wheel fills up exactly the aperture of the caſe, and the caps are ſo fitted, that the edge of the wheel comes in cloſe contact with them. *efgh* is a ſemicircular vacancy below the wheel, exactly filled up by the valves when extended. *i* is the tube to admit the ſteam, and *k* the pipe leading to the condenſer. *r* is the rod which ſhuts the valves as they approach it. The ſteam paſſing through *i*, turns the wheel round. The condenſer is worked by a crank in the axis, and a rod *bc* extending from it; this cauſes a conſtant vacuum in that part of the ſemicircular vacancy which lies between the cap *d* and the valve *ef* on which the ſteam preſſes.

The Uſe and Deſcription of a new-invented Inſtrument for Navigation. *By* J. Cooke, *Eſq. M.R.I.A.*

THIS inſtrument is intended to perform every caſe in plane, middle latitude, or Mercator's ſailing, and the advantages to be derived from it are theſe. 1ſt. No conſiderable error can exiſt in the work, as they become obvious in proportion to their magnitude, but in calculations the miſplacing of a ſingle figure produces an error of the greateſt conſequence. 2d. The errors of the preſs, which are conſiderable in the beſt tables of logarithms, are avoided. 3d. The art of keeping a ſhip's reckoning is by this inſtrument eaſily learned, and eaſily practiſed.

It is compoſed of a baſe, a perpendicular, a ſemicircle, and an index. The ſemicircle contains the degrees of the circle, and the points of the compaſs, the index perpendicular, and outſide edge of the baſe repreſent the diſtance, departure, and proper latitude reſpectively, being equally graduated, and each diviſion ſtands for a mile. In the baſe is another line, repreſenting the meridional parts, engraved on a cylinder, contained within a groove in the baſe. By placing the inſtrument in a ſituation ſimilar to that which the caſe requires, from the nature of ſimilar triangles, every part in the required triangle will be aſcertained.

The latitudes and longitudes of two places being given to find the direct courſe and diſtance between them.

Lat. 50°..50′ N. Long. 19°..00′ W.
Lat. 54°..30′ N. Long. 15°..30′ W.

According to Mercator's ſailing. Move the center of the ſemicircle to the meridional degree, correſponding with the latitude departed from, 50° 50′ N. then let the edge of the perpendicular cut the meridional parts of the latitude, 54° 30′ N. move the index, until it cuts the difference of longitude, 3° 30′ on the perpendicular, and it will mark the courſe 30° 10′ or N. N. E. ¾ E. nearly on the ſemicircle.

For the diſtance; the index being ſcrewed to this courſe, and the center of the ſemicircle and edge of the perpendicular moved as before, the perpendicular will cut the diſtance 254,7 miles on the index.

On the principles of middle latitude ſailing, thus: Half the ſum of both latitudes taken from 90° is the complement of the middle latitude, 37° 20′, and the difference of longitude is 3° 30′ or 210 miles.

Move the center of the ſemicircle to the proper latitude departed from, 50° 50′ N. and the edge of the index to the complement of the middle latitude 37° 20′ on the ſemicircle, let the edge of the perpendicular interſect the point 210 miles on the index, and 128 the departure will be marked on the perpendicular, then move the edge of the perpendicular to 54° 30′, and the index to 128 on the perpendicular, then will the perpendicular mark the diſtance on the index 254,7 miles, and the index will mark the courſe on the ſemicircle 30° 10′ as before.

Other caſes are given, but from theſe two the nature and uſe of the inſtrument will be clearly ſeen, by every one acquainted with the principles of navigation.

Explanation of the Inſtrument. See Plate XVII. Fig. 2.

The ſtock *a b c d* is a parallelopiped: The length from *a* to *b* is two feet, the breadth from *a* to *d* two inches, and the depth is one inch and half. This ſtock is perforated longitudinally, ſo as to be capable of containing within it *e f*, a cylindrical piece of timber one inch diameter. *g h* is an aperture on the ſurface of the ſtock, about a quarter of an inch wide, which diſcloſes one-twelfth part of the ſurface of the cylinder contained; the edge *d c* is divided into twelve parts, each of theſe are ſubdivided into ſix parts, and each of theſe are again ſubdivided into ten parts. The ſurface of the cylinder is divided longitudinally into twelve parts, and on each of them is engraved a portion of a line of meridional parts twenty-two feet long, which contains the meridional parts for every minute from the equator as far towards the pole as ſailing is practicable, and the ſmalleſt diviſion on it is not leſs than $\frac{1}{10}$th of an inch. By rolling and ſliding this cylinder any part of any line on it may be brought into any poſition which may be required; the box *i* is engrooved into the edge of the ſtock *a b*, ſo that it may move freely from *a* to *b*; a limb from this box extends to *k*, which ſerves to mark that degree of the perpendicular *i l*, which is parallel to the center of the ſemicircle *m*; *i l* is two feet long, and graduated on both edges as the ſtock; it is perpendicular to the ſtock, and is fixed in the box *i*, by which it may be moved from *a* to *b*. *o p n* is a ſemicircle of ſix inches radius, engraved as appears in the plate, which ſlides freely from *c* to *d* in a groove in the edge of the ſtock *c d*: *m q* is the index moved on the center *m*, the edge of which marks the courſe on the ſemicircle; it is two feet long, and divided into ſeventy-two parts, each of which are ſubdivided into ten parts, and are equal to the ſubdiviſions of the lines on the ſtock and perpendicular: *r* is a nonius attached to the index to ſhew the minutes of the angle of the courſe *q m o*. S is a nonius compoſed of concentric ſemicircles, which ſlides along the edge *q m*, to the interſection of the perpendicular and index, where it ſerves as a nonius to both; below *x* is a ſmall piece of ivory, with a mark on it to point out the degree of the line *d c*, which is perpendicularly under the center of the ſemicircle.

Obſervations.

Obſervations made on the Diſappearance and Reappearance of Saturn's Ring in the Year 1789, *with ſome Remarks on his diurnal Rotation. By the Rev.* H. Ussher, *D.D. &c.*

THE firſt diſappearance in May was, from the ſtate of the weather, not obſerved: on Auguſt 21, the ring was inviſible, but its ſhadow, though faint, was viſible on the body. Equally ſo on Auguſt 26 and 27. On Auguſt 30, the ring was viſible, particularly on the eaſt ſide, with the forty-inch achromatic. On October 1, the ring was juſt viſible on the eaſtern ſide only with the double achromatic, and with the tranſit inſtrument. On the 3d, it was not viſible with the tranſit inſtrument. At Cork it was ſeen on the eaſtern ſide to the 5th, till 10*h*..30′ with a reflecting teleſope, power 300.

Saturn, diveſted of his ring, appears exceedingly oblate, and by accurately meaſuring the equatorial and polar diameter, his time and rotation may be deduced on the principles laid down in the 19th propoſition of the third book of Newton. Let Δ = the earth's denſity, and δ that of Saturn. D = Saturn's greater diameter d the leſs. Then the time of Saturn's ſidereal rotation = $\sqrt{\frac{d \times \Delta \times 1 \quad \times 1}{\delta \quad 229 \quad D-d}} \times 23'..56''$. From a number of obſervations, Saturn's diameters, reduced to his mean diſtance, are 18″,12, and 15,855; and hence the formula gives for Saturn's ſidereal rotation 10*h*. 12′ $\frac{1}{2}$; but taking the denſity of Saturn from De la Lande, it comes out 12*h*. 55′$\frac{1}{3}$; and with this laſt denſity, and Bouguer's ratio of the earth's diameter, it comes out 14*h*. 44′$\frac{1}{2}$ nearly.

The following method of determining the quantity of matter in any planet is certainly true in theory.

The axis major of the earth's orbit, as it revolves round the common center of gravity of the earth and ſun = 200000. Quantity of matter in the earth = 1, that of the ſun 352813, the parallax being 8″,6. By prop. 60, B. 1. of Newton, $\sqrt[3]{352814} : \sqrt[3]{352813}$ :: axis major of an ellipſe round the common center of gravity, to the axis major of one which would in the ſame time be deſcribed round the ſun at reſt.

Venus's axis major round the common center of gravity = 144662 by obſervation. In the ſubſeſquiplicate ratio of the periodical times of the earth and Venus take the earth's diminiſhed axis major to a fourth quantity, and we have the axis major of the ellipſe which Venus would deſcribe round a fixed ſun.

Let $\odot$ = ſun's quantity of matter, ♀ = that of Venus, m = axis major of her orbit round the common center of gravity. I = that deduced as above round the fixed ſun. Then $m : I :: \sqrt[3]{\odot + ♀} : \sqrt[3]{\odot}$ $\therefore m^3 : I^3 :: \odot + ♀ : \odot$ $\therefore I^3 : m^3 - I^3 :: \odot : ♀$. Q. E. I.

N. B. By taking the law of the denſities laid down by De la Land, the denſity of Saturn inſtead of ,10448, his number comes out ,18351, much nearer to Newton's, which, reduced to this ſcale, would be ,16750. Newton's erred in the quantities of matter, by applying the ſolar parallax 10″,5 inſtead of 8″,6.

Account of two Parhelia obſerved Feb. 25, 1790. *By the Rev.* Henry Ussher, *D.D. &c.*

AT four in the afternoon, on my way from Dublin to the Obſervatory, I remarked that the ſun's light was uncommonly pale, and I ſaw a corona and two parhelia. The parhelia were in the ſun's almacantar, having the priſmatic colours, the red being next the ſun: their tails, parallel to the horizon, were about a degree and a half long, and there was no luminous circle parallel to the horizon. The corona in which were the parhelia, was 22°..24′ in ſemidiameter, rather elliptical, the longer diameter tending to the pole of the dipping needle.

In Dublin the corona was manifeſtly priſmatic, but in the clear air of the Obſervatory it was a vivid white. It continued viſible, though gradually decaying, for thirty-five minutes, and was at length obſcured by ragged clouds coming with the wind from W. S. W. which were far below the ſeat of the parhelia. A tempeſtuous night followed; and the barometer, which had been riſing, began to fall immediately, and in the courſe of the night fell eight tenths of an inch.

An Eſſay towards aſcertaining the Population of Ireland. By Gervase Parker Bushe, *Eſq.*

TO this eſſay is annexed a paper compiled from the ſurvey books of 1788, by which it appears that the number of houſes in Ireland in the year 1777, was 448,426; in 1785, 474,322; and in 1788, they amounted to 621,484. Of the latter the population had been taken in 14,108 houſes, and amounted to 87,895, or nearly 6¼ to a houſe.

Mr. Buſhe ſays he has diſcovered ſeveral errors in this paper, particularly that there are a great number of houſes ſuppreſſed, ſo that the houſes may be preſumed to amount to 650,000, and if theſe contain an equal number with the houſes whoſe population has been returned, the whole number of inhabitants may be computed at 4,040,000.

According to Sir W. Petty's calculation, the houſes in 1672 amounted to 200,000, and the inhabitants to 1,100,000. Mr. Buſhe thinks there muſt be ſome error in this account, as the increaſe could not poſſibly have been ſo rapid.

Letter of Mons. Pouget to Mr. Kirwan, on the Condenſations produced by the Mixture of Alkohol with Water.

ON examining the ſpecific gravities of fluids, and the proportions of the augmentations of denſity produced by the mixture of alkohol and water; the writer conceived the hope that he might arrive at the general law of theſe penetrations or abſorptions of one liquor by another; and in conſequence, laid the plan of a very extenſive courſe of experiments on the ſubject. He has only found leiſure however to execute a few, reſpecting mixtures of ſpirit of wine with water, of which he gives the following account.

He found a great difficulty on ſetting out, in determining the fixed point from whence the purity of alkohol ſhould be reckoned. This is well known to be a mixed fluid, and no certain proceſs exiſts of freeing it from all its water, and leaving the alkohol pure and unchanged. He was therefore obliged to content himſelf with reducing it by repeated rectifications to a certain ſpecific gravity, which was, to water, as 0,8199 to 1, at the temperature of 15 degrees of Reaumur's thermometer. In his mixtures of this with water, he always fixed the proportions, not by weight, but by bulk; and he compoſed ten mixtures, the firſt containing nine meaſures of alkohol and one of water, the ſecond, 8 and 2, and ſo on, till the laſt had only one of alkohol to 9 of water. But as actual meaſures are uncertain, he always employed the balance to determine the known ſpecific weights, by which 10,000 grains of water and 8199 of alkohol, formed equal volumes.

After all theſe mixtures were thoroughly blended and cooled, the ſpecific weight was found by the hydroſtatic balance. He likewiſe uſed another inſtrument which he thought ſtill more accurate, the areometer of Fahrenheit. That which he employed was of copper, about three cubic inches in bulk, furniſhed with weights of the ſhape of an olive, of equal volume, but different gravity, which might be conveyed to the bottom of the inſtrument in order to ballaſt it.

Knowing the real or phyſical ſpecific gravities of mixtures of alkohol and water, taking a medium of a great number of obſervations made at the ſame temperature of 15 degrees, and comparing them with the ſpecific mathematical gravities calculated by the ſimple rule of mixture, we may from thence derive the augmentation of denſity, or diminution of volume in the total maſs produced by the mutual penetration of fluids. For calling the phyſical ſpecific gravity A, the mathematical ſpecific gravity B, the number of meaſures compoſing the total maſs n, and that to which it is reduced by the effect of penetration $n \cdot x$, it is evident, ſince this augmentation of denſity does not diminiſh the weight of the total maſs, that $n\ B = \overline{n-x} \times A$. then $x = \frac{A-B}{A} \times n$, or making $n = 1$, $\frac{A-B}{A}$, which expreſſes the diminutions of the total volume, or the quantities of fluid abſorbed during the mixture.

The following table contains the reſults of the author's experiments, in which the diminutions of the total volume is ſuppoſed $= 1$ of each of the mixtures calculated according to the above formula. He has alſo calculated in the ſame manner from the experiments of M. Briſſon, publiſhed in Mem. de l'Acad. des Sciences de Paris, 1769.

According to my experiments.		
Number of meaſures.		Diminutions of total volume = 1.
Of Water.	Of Alkohol.	
1	9	0.0109
2	8	0.0187
3	7	0.0242
4	6	0.0268
5	5	0.0288
6	4	0.0266
7	3	0.0207
8	2	0.0123
9	1	0.0044

According to M. Briſſon's experiments.		
Number of meaſures.		Diminutions of total volume = 1.
Of Water.	Of Alkohol.	
1	15	0.0063
2	14	0,0115
3	13	0.0157
4	12	0.0189
5	11	0.0215
6	10	0.0235
7	9	0.0251
8	8	0.0257
9	7	0.0243
10	6	0.0217
11	5	0.0189
12	4	0.0144
13	3	0.0099
14	2	0.0057
15	1	0.0021

The total diminutions are leſs in M. Briſſon's experiments, becauſe his alkohol was leſs dephlegmated.

It appears from theſe tables that the diminutions of volume follow a regular progreſſion, the greateſt anſwering to the mixture of equal parts, and the reſt decreaſing towards the two extreme terms. They muſt therefore be determined by a general law, which the writer thus attempts to explain.

Conſidering the alkohol as diſſolved by the water, which has abſorbed and retains a part in its pores, the quantity abſorbed muſt be in proportion to thoſe of the ſolvent and the ſolvend. Thus, in a mixture of 9 meaſures of alkohol with one of water, this meaſure of water will abſorb a quantity of alkohol as 9; in one of 8 alkohol and 2 water, each meaſure of water will abſorb a quantity as 8, but which muſt be multiplied by 2, the number of meaſures of water, to obtain the total diminution. By conſequence, the dimunitions of volume of each mixture will be to each other in a ratio compounded of the number of meaſures of alkohol and water forming it.

Thus, 1×9, 2×8, 3×7, 4×6, &c. And in general, taking for conſtant the diminution at equal parts, and calling it c, calling alſo the total number of meaſures n, the number of meaſures of alkohol in any mixture x, and the augmentation of denſity or diminution of bulk z, we ſhall have, $c : z :: \frac{n}{2} \times \frac{n}{2} : \overline{n-x} \times x$ and $z = \frac{4c}{n^2} \times \overline{nx-x^2}$. or making $n = 1$, $4cx-4cx^2$. According to this formula he has calculated the augmentations of denſity of all the mixtures of the above tables, taking in each the term which anſwers to the mixture of equal parts as conſtant. It turns out thus;

In Table 1.

No.	Calculated Diminutions.
1	0,0103
2	0,0184
3	0,0242
4	0,0276
5	
6	0,0276
7	0,0242
8	0,0184
9	0,0103

In Table 2.

No.	Calculated Diminutions.
1	0,0060
2	0,0112
3	0,0157
4	0,0193
5	0,0221
6	0,0241
7	0,0253
8	
9	0,0253
10	0,0241
11	0,0221
12	0,0193
13	0,0157
14	0,0112
15	0,0060

Theſe calculations exactly agree with the writer's experiments, and alſo thoſe of M. Briſſon, for all mixtures where the alkohol is in greater quantity than the water; but not for thoſe where it is leſs. Theſe are much leſs than the calculation indicated, and the more ſo, the greater the proportion of water. There is therefore in theſe caſes a law which acts in contradiction to the firſt, and oppoſes its effect. This negative cauſe is probably the attraction of the particles of water to each other, which oppoſes their union with another ſubſtance. It is overcome by the ſtronger affinity of alkohol, when that is the greater or an equal part of the maſs, but it becomes active when the water is in the greateſt proportion. This is given only as a conjecture, but one ſtrengthened by ſome experiments; particularly a fact well known to dealers in ſpirituous liquors, which is, the extreme difficulty of perfectly combining a little ſpirit of wine with thoſe which are too weak.

Although the author has not diſcovered the law by which the differences of augmentation take place, yet as he has eſtabliſhed a formula by which that of all mixtures in which the alkohol is at leaſt half of the maſs may be calculated, it will ſuffice for practical purpoſes, as all the brandies and ſpirits of wine in commerce are more ſpirituous than equal parts of his alkohol and water. Thus, in any mixture of water and alkohol, the number of parts of each may be diſcovered; for by making,

The number of meaſures of the entire maſs, or the total volume - $= 1$
That of meaſures of alkohol in any mixture - - $= x$

The diminution of volume of the mixture at equal parts found by experiment $= c$

The diminution of volume of the mixture containing x meaſures of alkohol is by hypotheſis - - - - $= 4cx - 4cx^2$

The ſpecific weight of the water - - $= a$

The ſpecific weight of the alkohol - - $= b$

The ſpecific weight of the unknown mixture - - $= y$

We ſhall have, ſince the augmentation of denſity makes no change in the weight of the maſs, $\overline{1-x} \times a + bx = \overline{1-4cx+4cx^2} \times y$.

Equation by which may be concluded the value of x, or the proportion of alkohol, if the ſpecific gravity of the mixture be known; or determine this ſpecific gravity, value of y, if the proportions of alkohol and water be known.

$$x = 0.5 - \frac{a-b}{8cy} + \sqrt[2]{\frac{a-y}{4cy} + \left(\frac{a-b}{8cy} - 0.5\right)^2}$$

$$y = \frac{a-ax+bx}{1-4cx+4cx^2}$$

and making $a=1$, $b=0.8199$, $c=0.0288$.

$$x = 0.5 - \frac{0.1801}{0.2304y} + \sqrt[2]{\frac{1-y}{0.1152y} + \left(\frac{0.1801}{0.2304y} - 0.5\right)}$$

$$y = \frac{1-0.1801x}{1-0.1152x+0.1152x^2}.$$

The dilatations of mixtures of alkohol and water in different temperatures is the next point to be conſidered, but for this the writer has found no certain rule, and leaves it to be determined by experiment in each particular caſe. However, as he has found that the dilatations of brandies, the ſpecific gravities of which do not differ more than one hundredth, may without ſenſible error be conſidered as ſimilar and proportional, he propoſes a mode of employing an areometer and thermometer together, and uniting the two inſtruments and their ſcales, ſo that that of the thermometer may ſerve for the graduation of the areometer.

Thoughts on the Hiſtory of Alphabetical Writing. By MICHAEL KEARNEY, D.D.

AFTER ſlightly mentioning the opinions of various writers on this ſubject, Dr. Kearney proceeds to that of Dr. Warburton, who thinks that picture writing, or hieroglyphics, firſt prevailed, the ſign at firſt reſembling the thing, as may ſtill be obſerved in ſome of the Chineſe characters. Monſ. Goguet, in his *Origine des Loix et des Arts, &c.* conjectures that the next ſtep was made by the introduction of marks, denoting ſyllables, a mode which ſtill prevails among the Ethiopians and ſome Indian nations. With theſe conjectures Dr. Kearney agrees, and ſupports his opinion with the following reaſons.

" It ſeems to me, that it may be accounted for in this manner: we cannot ſuppoſe that writing was improved even to this degree of excellence before language was in ſome meaſure cultivated: but one of the firſt artifices, that occurs in the refinement of language, is compoſition or the union of diſtinct words in the formation of new terms, which the increaſed wants and enlarged ideas of men in the progreſs of ſociety would require. To expreſs ſuch compound ſounds, the marks of the ſeveral conſtituent ſounds would be joined together. It was ſoon obſerved, that many of theſe ingredient ſounds were the ſame with others non-ſignificant, that has occurred as parts of uncompounded words, that is, as ſyllables: hence was eaſily ſuggeſted the artifice of denoting ſuch ſyllabic parts by diſtinct marks; the combination and varied arrangement of which would repreſent the numerous words of language compendiouſly, without the multitude of ſigns which verbal notation required. To this ſyllabic alphabet, it appears to me, that one entirely compoſed of conſonants ſucceeded. The mind being now accuſtomed to analyſis, the reſolution of words into ſyllables would in time be followed by that of ſyllables into their component elements. But the variety of ſyllabic ſounds chiefly ariſing from organic articulations or conſonants; and the number of vowels or ſimple breathings being few, men would be contented to give marks to the firſt, leaving the others to be furniſhed by the reader. This conjecture becomes more probable, if, according to the opinion of Lord Monboddo, ſyllables in the primæval languages contained, each only one conſonant. It is alſo ſupported by, and accounts for the nature of the Hebrew and ſome other oriental alphabets, which have no characters denoting vowels, the Maſoretic punctuation being novel. In all the weſtern alphabets both conſonants and vowels have letters appropriated to them; becauſe the art of writing was not imported from Aſia into Europe, until the want of vowel marks had been found to be inconvenient. The addition of ſuch marks brought this wonderful art to its preſent ſtate of perfection."

Brief Strictures on certain Obſervations of Lord Monboddo reſpecting the Greek Tenſes. By

Arthur Browne, *LL.D. F.T.C. M.R.I.A.*

DR. BROWNE prefaces his diſſertation by an explanation of the preciſe ſenſe which he has annexed to certain terms.

I. *Aoriſts or Indefinites.* Dr. Browne calls thoſe tenſes *aoriſts* in which the verb does not *expreſs* (though it may ſometimes imply) whether the action ſignified be perfected or imperfect.

II. *Definite,* by which is meant the tenſe, in which the verb expreſſes the perfection of the action.

The poſition of Lord Monboddo which Dr. Browne controverts, is, "*That in Greek the ſecond future and ſecond aoriſt mean nothing different from the firſt tenſes of the ſame name, and are only old obſolete preſents and preterimperfects preſerved after the verb was moderniſed merely to vary and enrich the ſound of the language.*"

Dr. Browne's arguments are as follow:

1. The firſt aoriſt has much more frequently a definite meaning than the ſecond, which appears generally to be uſed indefinitely; for though, as in Homer, Book X. l. 556, ȣπω ιδον, ȣδ' ενοησα occurs, wherein ιδον appears to have a definite ſignification, yet ſuch inſtances are comparatively few. The firſt aoriſt is moſt frequently uſed as a paſt definite, its proper meaning therefore being of a *definite* nature, it cannot be conſidered as *properly* an aoriſt.

2. Such a definite as the firſt aoriſt was wanting in the Greek language, and is not ſupplied by the preterperfect, for Dr. Clarke, Mr. Huntingford, and Lord Monboddo himſelf, have proved that the tenſe, uſually called in Greek the preter or paſt

perfect, is properly a compound of the paſt and preſent, implying that the action has been done and ſtill continues to be done: e. g. Αμφιβεβηκας, thou haſt protected, and doſt ſtill protect; τεθαυμακας, thou haſt admired, and doſt ſtill admire. It is clear, therefore, that there ſtill remains to be ſought ſome other tenſe to expreſs the time of the performance of an action which was perfected at a time paſt, and has ceaſed to continue; nor can this tenſe be, as Dr. Clarke would have it, the preterpluperfect; that denoting an action paſt and perfected at a time antecedent alſo to a paſt time: therefore no other tenſe remaining, it is probable that the original intention of the firſt aoriſt was to expreſs the real preterperfect time of philoſophic grammar.

3. The argument is ſtill farther confirmed by Lord Monboddo's extenſion of Dr. Clarke's theory of the preterperfect. Lord Monboddo allows that the preterperfect cannot expreſs the real paſt perfect time, and proceeds to ſupply the deficiency, by conſidering the aoriſts uſed indefinitely and indiſcriminately as anſwering the purpoſe: theſe tenſes, however, in the meaning by him aſſigned to them, ſignify only the paſt indefinite, and he has not pointed out any tenſe ſignifying the paſt perfect; he muſt therefore either mean, that there is in nature no paſt perfect (which would contradict his own diviſion of the paſt into perfect, imperfect, and indefinite); or muſt allow that he has omitted to ſhew any correſponding tenſe in the Greek grammar.

4. The ſpeaking of an action as merely paſt, i. e. indefinitely, does not exclude the preſent. "He ſpoke well," does not imply that he may not be ſpeaking ſtill. But when we ſay "he has been a good ſpeaker," we exclude all idea of the preſent: indefinites, it is clear, could not anſwer the purpoſe.

5. Allowing Lord Monboddo's extenſion of Dr. Clarke's theory to be too refined, that the exceptions to Dr. Clarke's explanation of the preterperfect are as numerous as they ſeem to be, and that it often means an action paſt and diſcontinued, even in its conſequences; in this caſe it is diſtinguiſhable from the firſt aoriſt, and has a peculiar meaning of its own; the preterperfect meaning an action *lately* perfected, the firſt aoriſt denoting a tranſaction which took place *ſome time ago*. Thus Archimedes cried out ευρηκα, becauſe he had juſt at that moment ſolved the difficulty. Neſtor, on the contrary, uſed ωμιλησα, (Iliad i. l. 261.) when ſpeaking of heroes with whom, *in former times*, he had been converſant; not but that there are ſome exceptions to this rule, e. g. Il. iii. 367, 368, as there are to Dr. Clarke's, and every other theory on the ſubject.

6. There is another perceptible difference between the two aoriſts, the firſt being generally uſed when ſpeaking of an action that has been *often* done; thus in the beginning of the Memorabilia, Xenophon uſes πολλακις εθαυμασα, *I have often wondered.* The ſecond aoriſt is ſeldom if ever uſed to denote a ſrequentative; for though Lord Monboddo has aſſigned to it this office, as well as to the firſt, it is obſervable, that from the latter alone he draws his examples.

From what has been ſaid therefore, it appears, that the *ſecond aoriſt* is the only proper indefinite; that when uſed as a definite, it errs from its original uſe; and that it is doubtful whether it ever be a definite expreſsly, though it may be ſo by implication.---That, on the contrary, the primogenial uſe of the *firſt aoriſt* is to expreſs a paſt definite, and of a peculiar nature, viz. an action totally paſt, and not now continued.---That the *ſecond aoriſt*, even when uſed definitely, only ſhews that the action was perfected at a time paſt, without determining *when*; whereas the *firſt aoriſt*, in its ſtrict and proper ſignification, implies that it was done a conſiderable time ſince.

---That the firſt aoriſt is uſed as a cumulative, or to expreſs the frequency of an action, ſenſes ſeldom, if ever, communicated to the ſecond aoriſt.---And, that whenever the two aoriſts ſeem to be uſed indifferently as paſt definites, there is a beautiful contraſt intended; that this is evident, becauſe the firſt aoriſt often cannot be conſtrued without the aſſiſtance of an auxiliary verb, whereas the ſecond always can.

Dr. Browne proceeds briefly to conſider the two future tenſes; and obſerves upon Lord Monboddo's aſſertion, "that the Greeks have no one word to expreſs the "future perfect or imperfect, that both futures are merely indefinite, and that though "they could expreſs "I ſhall write," by γϱαφω, yet that if they wiſhed to ſay, "I "ſhall be writing," they muſt uſe γϱαφων εσομαι, uſing a circumlocution."

1. The fact is, that the future perfect is very frequently indeed expreſſed by one word in the infinitive, v. g. Il. ii. 412. 2. That there is no difficulty in finding inſtances, except in the indicative mood---that the reaſon why inſtances are rare in the indicative is, that the future perfect of the indicative can ſcarcely occur, except in dialogue or oration, and that in the dramatic writers it is expreſſed by the participle and genitive, &c. but ſcarcely ever by the circumlocution which Lord Monboddo deſcribes. 3. That inſtances of the future perfect ſubjunctive perpetually occur, formed by the ſecond future, e. g. Il. i. οτε κεν τοι ααπτους χειϱας εφειω, and alſo Soph. Œd. Col. 1526.

Evil Effects of Polytheiſm on the Morals of the Heathens. By a Young Gentleman of the Univerſity of Dublin.

THIS writer lays down as a baſis, that falſe notions of the Deity will ever produce more or leſs immorality in our lives. This he proceeds to confirm by conſidering the moral effects which the popular theology of the heathens was calculated to produce. *Polytheiſm* he ſays, ſtrikes at the ground work of all morality. "With the *unity* of God the immutability and permanence of moral rectitude is immediately connected. Where is the permanence or immutability of virtue, if the divine will be not immutable and permanent? And how can the divine will be immutable or permanent, if there be a *plurality* of Gods? Admit a plurality of wills, and a contrariety is poſſible: but if there be a contrariety, not only the uniformity of virtue is deſtroyed, but the ſame action may become at once virtuous and vicious, as that action may to one divinity be agreeable which is diſpleaſing to another."

Our author then proceeds to combat Mr. Hume's aſſertion, "that polytheiſm was the primary religion of man," which he contends was impoſſible, if the creation of a firſt man be true; but that when men multiplied in the earth, different men formed different conceptions of the Deity, and fancied gods agreeable to their various inclinations.

Account of a Singular Cuſtom at Metelin, with ſome Conjectures on the Antiquity of its Origin. By JAMES *Earl of* CHARLEMONT.

LORD Charlemont tells us, the women in Metelin ſeem to arrogate to themſelves the departments and privileges of men. The eldeſt daughters here inherit, and the ſons are portioned with ſmall dowers, or turned out to ſeek their fortunes. If a man has two daughters, the eldeſt is entitled to her mother's poſſeſſions;

the ſecond does not inherit any thing. She is ſtyled a Calogria, which properly ſignifies a religious woman or nun, and ſerves her ſiſter as a menial ſervant, and wears a habit peculiar to her ſtation; a ſort of monaſtic dreſs, coarſe, and of dark brown. The advantage ſhe enjoys over her ſiſter is, that the elder before marriage, is never permitted to go abroad, or ſee any man, her neareſt relations excepted; but the Calogria is at perfect liberty. On the contrary, after the ſiſter is married ſhe enjoys every liberty, the family fortune is her's, which ſhe ſpends as ſhe pleaſes, her huſband, father, and mother are dependent upon her, and the Calogria is treated as a ſervant. The ill effects of this cuſtom does not end here. The father and mother have to ſtruggle to gain a ſecond fortune, and if they have a third daughter, this they are obliged to give to her, and the fourth daughter, if there be one, becomes her Calogria, and ſo on alternately. A mariageable daughter can compel her father to procure her a huſband, and it is not uncommon to ſee a father and mother reduced to indigence, while the daughter lives in affluence.

The ſons, as ſoon as they are of an age to gain a livelihood, are turned out, and reduced to live by their labour, 'till they have got together ſome competency, and then they marry and are henpecked in their turn. There are few who break through theſe cuſtoms, and thoſe are looked on as men of a criminal diſpoſition, and deſerters of their country's cuſtom.

Lord Charlemont was informed of theſe extraordinary particulars by the French conſul, and his own obſervations of the deportment of the ladies evince the truth of them. The women in general aſſume a manly air, they ride a horſe aſtride, while the men ſit ſideways: and his lordſhip was informed that the huſband is moſtly diſtinguiſhed by his wife's family name. The women have town and country houſes, in which the huſband dare not interfere; have ſervants of their own, and the huſband in every circumſtance appear only as the wife's domeſtic. They have a tradition on the iſland, that it was formerly inhabited by Amazons. Sappho, who was a native of this iſland, is ſaid to have had manly inclinations. Theſe lordly ladies are handſome in ſpite of their dreſs, which is diſadvantageous, and are not diſtinguiſhed by any thing ſo univerſally, as by the haughty and diſdainful air with which they ſeem to look down on all mankind, as creatures of an inferior nature.

His lordſhip ſays, he has carefully examined if any ſimilar uſage exiſted in ancient times, and at length he found in Herodotus an account of a cuſtom of the Lycians which bears a ſtrong reſemblance. Book I. Sect. 2, he ſays the Lycians call themſelves by the names of their mothers, and not their fathers. If any one aſks his neighbour who he is, to deſcribe himſelf, he recites his mother's genealogy. If a gentlewoman marries a ſlave, her iſſue is noble, but if a citizen or even the firſt among them take to wife a common woman, or a concubine, the children are degraded and ignoble. Plutarch mentions this cuſtom in his treatiſe on the virtues of women. Lord Charlemont from this ſtriking reſemblance endeavoured to find out ſome authority for the peopling this iſland, from Lycia, but could trace no ſuch origin. But from a paſſage in Diodorus Siculus tom. 1, v. 5, he thinks he can trace a remote ſource for the uſage in queſtion. This cuſtom is mentioned by Monſ. de Guys in his *Voyage Litteraire.*

Obſervations

Obſervations on the Deſcription of the Theatre of Saguntum, as given by Emanuel Marti, Dean of Alicant. By the Right Honourable WILLIAM CONYNGHAM.

AS the deſcription of that of Saguntum given by Emanuel Marti, the Dean of Alicant, and publiſhed amongſt his letters at the beginning of this century has been inſerted in the work of Monfaucon, and quoted in the laſt Tour through Spain by Don Antonio Ponz, as the moſt accurate and ſatisfactory account given to the public of an ancient theatre, Mr. Conyngham ſays, it may not be an unacceptable preſent to the Academy to lay before them ſome obſervations on the deſcription of it given by Dean Marti in the 9th letter of his 4th book.

The Dean ſeems to have fallen into the common error of thoſe who adopt a ſyſtem. Being perſuaded that this theatre was a Roman work, he previouſly determined what ought to be the diſpoſition of every part, as deſcribed by Vitruvius; and adapting all his obſervations to thoſe rules, he ſaw nothing but what correſponded with his ſyſtem.

This theatre is ſituated on the north-eaſt declination of the hill on which the renowned citadel of Saguntum is ſituated, where " *Eminet excelſo conſurgens colle Saguntos,*" and within one hundred and twenty yards of the wall. Advantage is taken of the ground for the diſpoſition of the ſeats: the ſeveral approaches from the town and entrances to the ſeats are contrived with great ingenuity, and ſo diſpoſed as to afford a convenient admiſſion, without incurring great expence in levelling and working the rock upon which it is founded.

This theatre is built entirely of limeſtone in even courſes of from ſeven to eight inches thick without any mixture of bricks. No ornament of architecture whatever appears to have been made uſe of on the outſide, nor in the part of the theatre allotted to the ſpectators, though probably the whole on the inſide was covered with cut ſtone, if not with marble, and the ſcena ornamented with columns, of which however no remains appear.

Dean Marti ſays the diameter of the orcheſtra is ninety-ſix palms, or ſixty-ſix feet Engliſh; but in this he muſt include the firſt bench, the orcheſtra being only fifty-eight, and the bench four feet broad: he is miſtaken greatly in the meaſurement acroſs the whole from angle to angle, by him ſtated to be three hundred and thirty palms, or two hundred and twenty-ſix feet and eleven-twelfths Engliſh. The diameter from angle to angle is two hundred and eighty three feet, and conſequently from the conſtruction of the theatre the exterior ſemicircle, including the platform that communicated to the corridor leading to the benches of the people, was four hundred and fifty-three feet ſix inches, that is, a diameter and a half and twice the fourth part of a diameter of the orcheſtra. Where the Dean found a ſemicircle of five hundred and ſixty-four palms, or three hundred and eighty-ſeven feet and an half Engliſh, I cannot conjecture. The height that he aſſigns to the ſumma cavea is one hundred and thirty-three palms and an half, or ninety-two feet eleven-twelfths, and to the top of the upper wall one hundred and forty-four palms and an half, or one hundred feet and an half. This varies very conſiderably from my meaſurement, which is only ſeventy-one feet; but part of the upper wall is deſtroyed.

He is evidently miſtaken when he aſſerts that there are fourteen benches appropriated to the knights; this is a ſtriking circumſtance in which the conſtruction of this theatre diſagrees with the rules for the Roman theatre.

Mr. Conyngham obſerved a particularity which is not taken notice of by the Dean. On the top of the principal precinctio there are ſeveral grooves cut in the ſtone, of about one foot ſix inches broad, placed two and two, at two feet aſunder, and alternately between the vomitoria. Might they not then be deſtined to receive the vaſes, mentioned by Vitruvius, as neceſſary for increaſing the ſound of the voice, and which he directs to be placed in the middle of the height, which here exactly correſponds, the top of the precinctio being thirty-two feet nine inches from the orcheſtra, the probable half of the heighth when the outſide wall was entire.

It is to be obſerved, however, that Vitruvius directs thirteen cells at twelve equal diſtances, but here there are only nine. Dean Marti ſays there are ſeven ſtairs communicating from the orcheſtra upwards; this I could not perceive, as the benches are ſo ruined it is not eaſy to diſcover where there were and where there were not ſtairs.

There is one window on each ſide, next the ſcena, which gives light to rooms under the ſumma cavea, and two doors, which lead to theſe and other detached rooms. Here it may be proper to obſerve the contrivance of the architect in managing the ſeveral approaches on the ſide of the hill, which are ſupported by walls and entrances made to the theatre, to communicate in the moſt convenient manner poſſible. Theſe entrances are uniformly contrived to give admiſſion on the level of the uppermoſt bench of the ſeveral claſſes, with ſtairs deſcending to the precinctio, which ſeparates each claſs from that immediately adjoining and below: a convincing proof that the two firſt claſſes of benches were not intended for one and the ſame order of citizens.

Theſe two main entrances on each ſide have communications with each other of ten feet wide, at thirty-eight feet ſix inches diſtant from the outſide of the theatre. On the eaſt ſide there is a double communication between theſe corridors, which appears to have been occaſioned by the form of the hill.

Another circumſtance diſtinguiſhing this from the Roman theatres is, that the orcheſtra is not divided in cunei, but ſhews two rows of places in its circumference of extraordinary breadth, and which being only one foot in heighth and too low for ſitting were probably appropriated to the chairs of the magiſtrates and other diſtinguiſhed perſons.

The conſtruction and ſituation of this theatre bear a ſtriking reſemblance to that of Athens, which Pauſanius tells us communicated to the Acropolis by a cave. That citadel towered upon a hill extended nearly eaſt and weſt like this of Saguntum: to the north, with a little inclination to the eaſt, was ſituated the theatre of Bacchus, which appears by the meaſurement of Le Roi to have been nearly of the ſame dimenſions with this: and Monſieur de Choiſeuil, in the Voyage Pittoreſque de la Greece, informs us, that the theatre at Sparta was ſituated in the ſame manner, and almoſt all the theatres that he met with in Greece.

The diviſion of the benches in this theatre, totally different from the theatres of Pompey, Marcellus and Pola, correſponds with that of the Grecians, as well as with thoſe of Taormina and Syracuſe: and though the original conſtruction of it, which is evidently upon the plan laid down by Vitruvius as characteriſtical of the Roman theatres, (that is, of being determined by the diſpoſition of four equilateral triangles, and differing from the Grecian theatres, determining, according to him, by three ſquares inſcribed in a circle whoſe diameter is equal to that of the orcheſtra) would ſeem to refer the building of this theatre of Saguntum to the æra of the Roman

man ſettlements in Spain; yet there are not wanting reaſons for doubting the validity of this argument, ſince the plans that have been lately publiſhed of the theatres in Sicily convince us that this rule was not peculiar to the Roman theatres. It may, therefore, be thought perhaps of a date much earlier, and of Grecian ſtructure, as it cannot well be ſuppoſed that a Grecian colony, powerful as the Saguntines, who reſiſted the whole ſtrength of the Carthaginians during a ſiege of eight months, would be leſs inclined to public amuſement, and leſs ſplendid in their preparations for them, than the numberleſs colonies ſettled in Sicily, in each of which a theatre ſeems to have been a neceſſary building, not only for their amuſements but for every purpoſe of the public aſſemblies of the people.

Letter from the Right Honourable W. Conyngham, being an Appendix to the above.

MR. CONYNGHAM has in ſupport of his former opinion, given the following meaſurement.

The relative meaſurements are as follow:

	Feet.	Inch.
Semi-diameter of the enterior circle of the Theatre of Athens	35	00
of Saguntum	29	00
Extent of ſcena at Athens	117	1
at Saguntum	118	00
Return of Scena at Athens	25	1
at Saguntum	21	4
Upper portico including inſide wall at Athens	13	6
at Saguntum	14	6
Width of benches of people at Athens	29	00
at Saguntum	23	3
Principle Precinctio at Athens	8	6
at Saguntum	8	6
Next diviſion of benches at Athens	14	10
at Saguntum	14	9
Total ſemi-diameter at Athens	124	4
at Saguntum	122	7

And concludes "ſome difference appears by a larger ſpace being allotted to the benches of the people in the Theatre of Athens, and being conſtructed on a larger circle it makes a *ſcena receſſior*, but by the three ſemi-circles inſcribed on the ſcena at Saguntum this muſt have appeared conſiderably larger than that of the former.---The general diſpoſition is however evidently the ſame, and appearing to be inconſiſtent with the rules laid down by Vitruvius for the conſtruction and arrangement of the Greek theatres, it ſeems to be an argument in favour of thoſe travellers who ſuppoſe this to be the theatre built by Herodes Atticus, and not the ancient theatre of Bacchus."

Letter from Mr. William Beauford, *A.B. concerning Ptolemy's Account of Ireland.*

THE account given of Ireland by Ptolemy the geographer, has on one ſide been ſuppoſed to have not the leaſt foundation in truth, and on the other, to be an accurate record of all the nations then inhabiting that iſland. Mr. Beauford takes a middle opinion, and ſuppoſes that it was derived from the information of mariners and merchants, who were acquainted with the coaſts and maritime parts, but knew little or nothing of the interior of the country. To ſuch parts, therefore, Ptolemy's names only belong, and he will be found to have given them and the ſituations of places more accurately than is imagined, except that the latitudes and longitudes are wrong.

Ireland is by Ptolemy denominated Ιουερνια, and by Strabo Ιερνε, which is agreeable to the name given it by the natives from the remoteſt periods, who always diſtinguiſhed their country by the denominations of *Eirean*, *Erin*, or *Ibh Eirean*, pronounced like *Ow Erin* or *Jov Erin*. He begins his deſcription with the northern coaſts, and firſt mentions the

Βορειον ακρον, or northern promontory, which is the preſent north cape, in the county of Donegal.

Ουεννικνιον ακρον ſeems to be the *Bhen nigh nion* of the Iriſh, pronounced nearly Vennicnion, being the moſt northern headland of Innis Owen, in the county of Donegal.

Ουιδουα ποτ. εκβολαι ſeems to be Lough Foyle, the *Loch Faibhail* of the Iriſh.

Αργιτα ποτ. εκβολαι, or mouth of the White River, probably is the *Abhan Ban* of the Iriſh, the preſent river Ban, in the county of Antrim.

Ῥοβογδιον ακρον, made by Ptolemy the moſt eaſtern point on the north coaſt, was probably Fair Head, in the county of Antrim, the *Riabhachdagh*, or fair cape of the Iriſh.

He proceeds to ſay, that on the weſt of this dwell the Venicnii, and that others on the eaſt were the Robogdii. Here he ſeems not to have obtained the country name of the people, but to have denominated them from the neighbouring capes.

Ptolemy then paſſes to the weſtern coaſt, beginning as before with the north cape.

Ραουιου ποτ. εκβολαι. This, which he places on the ſame latitude with the Vennicnium cape, but with a more weſtern longitude, was probably the *Abhuin Reabhlangadh* of the Iriſh, the preſent mouth of the river Ern.

Ναγνατα πολις επισημος. No ſuch city as this is mentioned by the Iriſh writers. By its latitude and longitude it ought to be ſituated in the barony of Carbury, and county of Sligo.

Λιβνιου ποτ. εκβολαι. This river ſeems to be the *Cluidh*, *Cluidhean*, or *Cluibhagh* of the Iriſh, the preſent Clew bay, in the county of Mayo.

Αυσοβα ποτ. εκβολαι, ſeems to be the *Abſidhe* or *Abhanſidhe* of the Iriſh, the preſent bay of Galway.

Σηνου ποτ. εκβολαι, was certainly the *Seanan* of the Iriſh, the preſent Shannon.

Δουρ ποτ. εκβολαι, was probably the bay of Dingle; but the old Iriſh name is loſt.

Ιερνου ποτ. εκβολαι, was *Abhuin Ibh Earnan* of the Iriſh, the preſent Bear-haven.

Νοτιον ἀκρον, or ſouthern promontory, was probably the *Ben Moiſaimh Beallen* and *Mullobhagbagh* of the Iriſh, the preſent Mizen-head.

Of the people inhabiting the weſtern coaſt, Ptolemy ſays, that after the Vennicnii, dwell the

Ερδινοι. Theſe were the northern *Ernai*, or *Eir Gall* of the Iriſh, and the ancient inhabitants of *Eir Dunnagh* or *Dal Eirnagh*, called in the Ulſter annals *Dalnarians*, comprehending the counties of Donegal, Fermanagh, Leitrim, and Roſcommon. Theſe were tribes of the *Fir Bolga*, and are by ſome learned men ſuppoſed to have been of Gothic and Germanic origin, ſettled in Ireland before the Chriſtian æra.

Ναγναται were the inhabitants of the barony of Carbury, in the county of Sligo.

Αυτεροι were evidently the ancient inhabitants of the *Ibh Errus*, the preſent barony of Erris, in the county of Mayo.

Γαγγανοι. The Romans probably denominated theſe people from their principal headland, in Iriſh *Cean Gibbne*, pronounced Kan Ganné, that is, Dog's Head, the preſent name. They were therefore the ancient inhabitants of Conmacnemarra, in Galway.

Ουελιβοροι, denominated from their headland, in Iriſh *Beal Ibh Eiragh*; the people about Kerry Head.

Ptolemy now doubles Notium Prom. and deſcribes the ſouthern coaſts on the Vergivian ocean.

Δαβρονα ποτ. εκβολαι. This was probably the *Dubh Riannagh* and *Abham mor* of the Iriſh, now Blackwater or Youghal river.

Βριγου (Ed. Pal. Βαργου) ποτ. εκβολαι. Appears to be the *Abhan Barragh* or *Berbhagh* of the Iriſh, and the mouth of the preſent Barrow.

Ιερον Ακρον, or Sacred Promontory, was called in Iriſh *Cean Grian Cradh*, now Greenore Point.

Of the inhabitants of the eaſt, Ptolemy places next to the Ouellaboroi, the

Ουτερνοι (Pal. Ed. Ιουερνιοι); probably the *Ibh Earagh* of the Iriſh, the ancient inhabitants about Bear-haven, and the ſouthern parts of Kerry, and a part of the ſouthern Ernai.

Ουοδιαι. The ancient name of this diſtrict is loſt, but they were probably the inhabitants of the ſouthern parts of the county of Cork.

Βριγαντες. No ſuch name is mentioned by the Iriſh, whence the Romans probably denominated them from their neighbouring river *Brigus* or *Bargus*. They ſeem to be the ancient inhabitants of the county of Waterford, called by the Iriſh *Hy Breoghan*, and the inhabitants, *Breaghnach* or *Breoghnach*, Britons. That theſe were aboriginally Britons is in ſome meaſure evinced from the mountains near which they dwelt, being to this day named *Cummeragh*, or Welſh.

Of the eaſtern coaſt, Ptolemy gives the following enumeration from the Sacred Promontory.

Μοδονου ποτ. εκβολαι; the *Abhuin Maidoc* of the Iriſh, the preſent Slany and harbour of Wexford.

Μαναπια πολις. Modern writers have not been able to aſcertain the true ſituation of this city, placing it at Waterford, Wexford, or Wicklow. It was probably ſomewhere on the river of Wexford.

Οβοκα ποτ. εκβολαι. This river is ſtill called in Iriſh *Oboca* or *Ovoca*, the preſent river of Arklow.

Εβλανα πολις. By the comparative latitude given to this city in Ptolemy, it was between the rivers Arklow and Boyne, the ſituation of Ruſh harbour, and may have been Luſk. Eblana has generally paſſed for Dublin, the Iriſh *Dubhleana*. But the word is probably of Teutonic origin, for the true indigenous name of Dublin has always been, as at preſent, *Blacli*, or *Ballicleath*.

Βουουινδα ποτ. εκβολαι; evidently the *Abhan Boand* or *Abhuin Bouind* of the Iriſh, the preſent river Boyne.

Ισαμνιον ακρον; thought to be St. John's Point, in the county of Down.

Ουινδεριος ποτ. εκβολαι; probably the *Abhan Daragh* or *Loch Cuan* of the Iriſh, the preſent bay of Strangford.

Λογια ποτ. εκβολαι; probably the *Loch Guis* or *Bella Fearſad* of the Iriſh, the preſent bay of Carrickfergus.

Ptolemy next ſpeaks of the people inhabiting the eaſtern coaſt, in doing which he returns from the north towards the ſouth.

Δαρνιοι, Pal. Δαρινοι; probably the ancient inhabitants of the Iriſh *Dairanii*, *Dairecalgaic*, *Dal Rieta*, *Dal na Ruiahe*, and *Dalraida*, the ſouthern parts of the county of Antrim.

Ουολουντιοι. Theſe ſeem to be the ancient inhabitants of *Ulagh*, *Uladh*, or *Ulidia*, the preſent county of Down.

Βλανιοι, Pal. Εβλανοι. The inhabitants of the Iriſh *Almeanna* or *Almain*, containing the coaſts from the Boyne to the Liffey. This diſtrict was alſo called *Acibh Leanna.*

Καυκοι. Theſe were the inhabitants of *Atha Cuachdagh* or *Atacdii*, the maritime parts of the county of Dublin ſouth of the Liffey.

Μαναπιοι, ſeem to be the inhabitants of *Acibh Mantann* or *Ibh Garchon*, a maritime diſtrict near Wicklow.

Κοριονδοι υπερ τους Βριγαντας. Probably the *Carimandii* of *Ibh German*, a maritime diſtrict near Wexford. They were alſo named *Martinii* and *Meragh*, and were probably Britons.

Ptolemy, having thus finiſhed his deſcription of the maritime coaſts, proceeds to the inland towns.

Ριγια appears by its lat. and long. to be *Eamania* or *Eamhan*, near Armagh, at preſent called *Rath n' Eavan*, or the fort of Navan.

Ραιβα, *Reban* on the Barrow, near Athy.

Λαβερος is evidently the celebrated *Tara* or *Teambra*, called alſo *Labbradh*.

Μακολικον, probably the *Cancora* of the Iriſh, near Kilaloe.

Ἑτερα Ριγια, *another Rigia*. From its ſituation ſeems to be the *Crogban* of the Iriſh, the ancient capital of Connaught, between Boyle and Elphin, in Roſcommon. There are ſtill remaining a rath and an ancient cemetery, called by the natives *Rioligh na Righ.*

Δουνον, ſeems to have been *Dunnamaes*, in the Queen's county.

Ιουρνις, Pal. Ιερνις, is thought to be *Cahir*, in the county of Limerick.

Ptolemy next ſpeaks of the iſlands which ſurround Ireland, among which he includes ſeveral of the weſtern iſlands, under the name of Εβουρα. The reſt are,

Ρικινα, *Rachlin* or *Raghlin*, on the coaſt of Antrim.

Μον Νησος, evidently the Iſle of Angleſea, though brought too near the coaſt of Ireland.

Ειδρου, Pal. Οδρου, ſuppoſed to be *Beg Eri*, on the coaſt of Wexford.

Λιμνου, *Lambey*, on the coaſt of the county of Dublin.

A Memoir

A Memoir reſpecting the Antiquities of the Church of Killoſſy, in the County of Kildare; with ſome Conjectures on the Origin of the Ancient Iriſh Churches. By Mr. W. BEAUFORD, *A. B.*

THE tower of the pariſh church of Killoſſy is round, founded on a ſquare baſe, nearly half of the preſent height, each ſide terminating in a pediment or triangle of equal altitude, from one of which proceeded the ſtone roof of the old church. This conſtruction is ſuppoſed to be unique in theſe iſlands; but in the iſland of Zante is, or was lately, a Greek church exactly on the ſame plan; alſo others in the various parts of the Levant. The inſulated round tower, and the ſmall old churches with the ſtone roofs and circular arches diſcovered in Ireland, and thoſe in England called Saxon, as well as thoſe in Spain named Moſarabic, greatly reſemble each other, and are probably all after the model of the Greek architecture in its decline. This architecture was introduced as early as the middle of the ſeventh century among the Anglo Saxons by Greeks, who followed Theodorus archbiſhop of Canterbury, and founded a ſchool or academy at Greekſlade. About 759 an academy was founded at Cordova by Abdoulrahman, and furniſhed with Greek profeſſors; alſo between 843 and 882, Charles the Bald eſtabliſhed a ſimilar one at Otranto. Both theſe were much frequented by all the people of the weſt; but the Iriſh chiefly reſorted to that of Cordova. From theſe academies the Grecian and Roman architecture of the middle ages became diffuſed through the weſt of Europe, but with certain differences according to the nation which adopted it.

The ſaxon churches were generally rectangular edifices, terminating in a ſemicircle at the eaſtern end, and their roofs low, ſcarcely viſible above the cornice. The ſteeples, when they had any, where generally ſquare, and placed either at the weſt end or ſides; though ſome, not common, were round. And they had generally under them a cript or under croft, for the preſervation of ſacred reliques, &c. after the manner of the Romans and Italians.

The Iriſh alſo had cripts to their ſtone churches, but theſe cripts were not under but upper crofts, ſituated in the roofs between the circular ſtone ceiling and the ſtone pediment roof; as in the churches of Glendaloch and Caſhel, agreeable to the cuſtom of the Maſſorabic Chriſtians, who ſtill uſe ſuch apartments as choirs. On this account the roofs of the Iriſh churches were raiſed remarkably high, and gave them a different appearance from thoſe of the Saxons. Another diſtinguiſhing feature between the Saxon and the Iriſh architecture, was the inſulated round tower of the latter, which the Anglo Saxons do not appear to have uſed, any more than the Italians, at leaſt very ſparingly; but numbers are to be found near the old Greek churches in the eaſt, which were by the Moſlems adopted as minarats to their temples, and watch towers to their fortreſs; as appears from ſeveral ſtill remaining on the Ebro, and in other parts of Spain.

The Iriſh do not appear to have adopted this ſpecies of architecture, or to have built with lime and ſtone the 9th century. From the beginning of the 11th, ſtone roofed criptic churches and round towers became common in Ireland; and this ſtyle continued till the introduction of the Norman and Gothic in the beginning of the 12th century, when it was diſcontinued.

With reſpect to the church of Killoſſy, the diſtrict in which it ſtands was anciently denominated *Magh Laſagh*, and a monaſtery was founded there by the O'Kelly's in the 8th century. This was burnt down in 833 and again in 984; and the church was rebuilt after that period of lime and ſtone, of which the tower now remains. After the arrival of the Engliſh in the reign of Henry II. this diſtrict was granted to Maurice Fitz Gerald, and Killoſſy became a pariſh church.

On the weſt end of the church are a number of artificial caves communicating with each other by ſmall apertures, which were the granaries or magazines of the ancient inhabitants, where they depoſited their proviſions, and into which they retreated in time of danger. In the Brehon laws they are mentioned by the name of *Log*, and numbers of them are diſcovered in various parts of the kingdom. Theſe of Killoſſy appear to have belonged to the monaſtery.

Tranſactions of the Royal Iriſh Academy.

Of the Strength of Acids, and the Proportion of Ingredients in Neutral Salts. By RICHARD KIRWAN, *Eſq. F. R. S. and M. R. I. A.*

THE former eſſays of Mr. Kirwan on this ſubject are known to the public. It has been his attempt in the following paper, to free them from the defects and imperfections under which they laboured.

§ 1. *Of the Proportion of Acid in the Mineral Acids.*

Of the Marine Acid. 100 cubic inches of marine acid air weigh 60 grs.; 10 grs. of water abſorb 10 of this air, and the ſpirit of ſalt thus formed occupies the ſpace of 13,3 grs. nearly. Hence its ſpecific gravity is 1,500 nearly, and that of the pureſt condenſed marine acid is 3,03. The ſpecific gravity of the ſtrongeſt marine acid that can eaſily be procured and preſerved is 1.196. 100 parts of this contain about 49 of that whoſe ſpecific gravity is 1,500, and which may be called ſtandard. By mixing this ſtandard ſpirit of ſalt with different proportions of water, the reſults have been obtained from which the following table is calculated.

Table of the Quantity of Standard Acid 1,500 *in Spirit of Salt of inferior Denſity, Temperature* 60°.

100 Parts.	Parts Standard.	100 Parts.	Parts Standard.	100 Parts.	Parts Standard
1,196	49	1,147	37	1,1036	26
1,191	48	1,1414	36	1,0984	25
1,187	47	1,1396	35	1,0942	24
1,183	46	1,1358	34	1,0910	23
1,179	45	1,1320	33	1,0868	22
1,175	44	1,1282	32	1,0826	21
1,171	43	1,1244	31	1,0784	20
1,167	42	1,1206	30	1,0742	19
1,163	41	1,1168	29	1,0630	16
1,159	40	1,1120	28	1,0345	10
1,155	39	1,1078	27	1,0169	5
1,151	38				

Of the Vitriolic Acid. Mr. de Morveau having obſerved to Mr. Kirwan, that the denſities accruing to mixtures of this acid with water greater than found by calculation, ſhould principally be aſcribed to the condenſation of the aqueous part, rather than of the acid; Mr. Kirwan felt the juſtice of the obſervation which ſubverted the inferences of his former calculations, but was at a loſs to find a better method of forming tables, till he attended to Mr. Pouget's letter read to the Academy *(Vid. Trans. for* 1789.*)* He could not procure oil of vitriol of the ſpecific gravity of 2,000 in the temperature of 60° which is taken for ſtandard; but from many experiments with acids of inferior denſity, he thinks that the condenſation of equal weights of this ſtandard acid and water amounts to $\frac{1}{7,5}$ of the whole. Then, by the application of Mr. Pouget's formulas, the ſucceſſive increments of denſity will be found as follows.

Parts Water.	Standard.	Increments of denſity.
5	95	,0252
10	90	,0479
15	85	,0679
20	80	,0856
25	75	,0699
30	70	,1119
35	65	,1213
40	60	,1279
45	55	,1319
50	50	,1333

By adding theſe increments to the ſpecific gravities found by calculation, and taking arithmetical mediums for the intermediate quantities of ſtandard, the firſt fifty numbers of the following table were made out; the remainder was formed by actual obſervation.

Table of the Quantity of the Standard Vitriolic Acid 2,000 *in Oil or Spirit of Vitriol of inferior Denſity.*

100 Parts.		Standard Temperature 60°.	100 Parts.		Standard.	100 Parts.		Standard.
2.000	—	100	1,6217	—	67	1,2847	—	34
1,9859	—	99	1,6122	—	66	1,2757	—	33
1.9719	—	98	1,6027	—	65	1,2668	—	32
1.9579	—	97	1,5932	—	64	1,2589	—	31
1,9439	—	96	1,5840	—	63	1,2510	—	30
1,9299	—	95	1.5748	—	62	1,2415	—	29
1.9168	—	94	1,5656	—	61	1,2320	—	28
1.9041	—	93	1,5564	—	60	1,2210	—	27
1.8914	—	92	1,5473	—	59	1,2101	—	26
1,8787	—	91	1.5385	—	58	1,2009	—	25
1,8660	—	90	1 5292	—	57	1,1918	—	24
1,8542	—	89	1.5202	—	56	1,1836	—	23
1,8424	—	88	1,5112	—	55	1,1746	—	22
1,8306	—	87	1,5022	—	54	1,1678	—	21
1,8188	—	86	1,4933	—	53	1,1614	—	20
1,8070	—	85	1,4844	—	52	1,1531	—	19
1,7959	—	84	1,4755	—	51	1,1398	—	18
1.7849	—	83	1,4666	—	50	1,1309	—	17
1,7738	—	82	1,4427	—	49	1,1208	—	16
1,7629	—	81	1,4189	—	48	1,1129	—	15
1,7519	—	80	1,4099	—	47	1,1011	—	14
1.7416	—	79	1,4010	—	46	1,0955	—	13
1,7312	—	78	1,3875	—	45	1,0896	—	12
1,7208	—	77	1,3741	—	44	1,0833	—	11
1,7104	—	76	1,3663	—	43	1,0780	—	10
1,7000	—	75	1,3586	—	42	1,0725	—	9
1,6899	—	74	1,3473	—	41	1,0666	—	8
1,6800	—	73	1,3360	—	40	1,0610	—	7
1,6701	—	72	1,3254	—	39	1,0555	—	6
1,6602	—	71	1,3149	—	38	1,0492	—	5
1,6503	—	70	1,3102	—	37	1,0450	—	4
1,6407	—	69	1.3056	—	36	1,0396	—	3
1,6312	—	68	1.2951	—	35	1,0343	—	2

The laſt eleven numbers were found only by analogy, obſerving the ſeries of decrements in the four preceding denſities.

Of the Nitrous Acid. The ſpecific gravity of the moſt concentrated ſpirit of nitre he could procure was 1,5543 in the temperature of 60°. This was ſo highly phlogiſtical and volatile, that is was impoſſible to make accurate experiments on it when mixed with ſmall proportions of water; but when mixed with an equal weight, its increaſe of denſity was about $\frac{1}{12}$ of the whole. The firſt fifty numbers of the ſubſequent table were formed by calculation according to Mr. Pouget's formula; the remainder by experiments as in thoſe of the vitriolic acid.

Table

Table of the Quantity of Nitrous Acid whoſe Denſity is 1,5543 in Spirit of Nitre of inferior Denſities. Temperature 60°.

100 Parts.		Parts Standard.	100 Parts.		Parts Standard.	100 Parts.		Parts Standard.
1,5543	—	100	1,4018	—	70	1,2586	—	44
1,5295	—	95	1,3975	—	69	1,2525	—	43
1,5183	—	94	1,3925	—	68	1,2464	—	42
1,5070	—	93	1,3875	—	67	1,2419	—	41
1,4957	—	92	1,3825	—	66	1,2374	—	40
1,4844	—	91	1,3775	—	65	1,2291	—	39
1,4731	—	90	1,3721	—	64	1,2209	—	38
1,4719	—	89	1,3671	—	63	1,2180	—	37
1,4707	—	88	1,3621	—	62	1,2152	—	36
1,4695	—	87	1,3571	—	61	1,2033	—	35
1,4683	—	86	1,3521	—	60	1,2015	—	34
1,4671	—	85	1,3468	—	59	1,1963	—	33
1,4640	—	84	1,3417	—	58	1,1911	—	32
1,4611	—	83	1.3366	—	57	1,1845	—	31
1,4582	—	82	1,3315	—	56	1,1779	—	30
1,4553	—	81	1,3264	—	55	1,1704	—	29
1,4524	—	80	1,3212	—	54	1,1639	—	28
1,4471	—	79	1,3160	—	53	1,1581	—	27
1,4422	—	78	1,3108	—	52	1,1524	—	26
1,4373	—	77	1,3056	—	51	1,1421	—	25
1,4324	—	76	1,3004	—	50	1,1319	—	24
1,4275	—	75	1,2911	—	49	1,1284	—	23
1,4222	—	74	1,2812	—	48	1,1241	—	22
1,4171	—	73	1,2795	—	47	1,1165	—	21
1,4120	—	72	1,2779	—	46	1,1111	—	20
1,4069	—	71	1,2687	—	45	1.1040	—	19

§ 2. *Of the Proportion of Ingredients in Neutral Salts formed with common Mineral Acids.*

The ancient mode of reſolving this problem being ſubject to various cauſes of inaccuracy, Mr. Kirwan has abandoned it for the following. He firſt ſaturates a known quantity of alkali or other baſis with an acid whoſe ſpecific gravity is known, and whoſe proportion of ſtandard is determined by the tables. He then makes another ſolution of a known quantity of neutral ſalt of the ſame ſpecies as that formed by ſaturation, and examines the ſpecific gravity of both in the ſame temperature, adding water to the ſtronger till their denſities become equal, and thence infers that an equal proportion of ſalt exiſts in both; but the proportion of one is known, and therefore that of the other, the weight of the whole being found, is alſo determined. Even this method is ſubject to a ſmall inaccuracy, for a ſlight exceſs of acid is always left, leſt any loſs of liquor ſhould enſue from trials of ſaturation with vegetable blues, which renders the denſity of the ſolution of the regenerated ſalt ſomewhat greater than the proportion.

Of Tartar Vitriolate. By a compariſon made with the greateſt care according to the principles here laid down, between tartar vitriolate made by ſaturation, and a ſolution of the ſame ſalt: the reſult is, 1ſt. that 100 parts of dry cauſtic veg. alkali take up nearly 92 of ſtandard vitriol. acid, or 82 of the ſtrongeſt vitriol. acid, and afford 182 of cryſtallized tartar vitriolate; 2d. that of this neutral, 100 parts contain

55 of mere alkali, and 45 of the ſtrongeſt vitriolic acid, equivalent to about 50,42 of ſtandard. There is no reaſon to ſuppoſe that this ſalt contains any water of cryſtallization, but rather the contrary; ſince in a red-heat continued for half an hour, it fell into powder, yet 100 grs. loſt only one, which might have been diſſipated.

Of Nitre. From the experiments on this ſalt it appears, 1ſt. that 100 grs. of pure vegetable alkali, ſaturated with nitrous acid, ſhould afford about 216 of nitre, and take up about 116 of the ſtrongeſt nitrous acid, equivalent to 120 of the ſtandard; 2d. that 100 parts of cryſtallized nitre, contain 46,15 of alkali, and 53,85 of acid ſtronger than ſtandard in the proportion above mentioned. Nitre contains no water of cryſtallization. In evaporation, part of it is carried off, whence the reſults of experiments by that mode have been very various.

Salt of Sylvius or muriated Vegetable Alkali. 1ſt. 100 parts pure veget. alkali take up 55,7 of the ſtrongeſt marine acid, equivalent to 115 nearly of ſtandard, and afford 155,7 grs. of ſalt of ſylvius. 2d. 100 grs. of this ſalt contain 64,2 of alkali; and 35,8 of the ſtrongeſt marine acid, equivalent to 73 nearly of ſtandard. It contains no water of cryſtallization.

Of Glauber's Salt. 1ſt. 100 parts pure mineral alkali take up 143 nearly of ſtandard acid, and ſhould afford 414 of dry cryſtallized glauber. 2d. 100 parts of cryſtallized glauber contain 24,16 of mere alkali, 34,54 of ſtandard acid, and 41,3 of ſuperfluous water; or, if the ſalt be heated to dryneſs, 100 parts of it will contain 41 of alkali, and 59 of ſtandard acid.

Of Cubic Nitre. 1ſt, 100 parts mineral alkali take up 136 of the ſtrongeſt nitrous acid, equivalent to 171 ſtandard, and afford 271 parts cryſtallized cubic nitre. 2d. 100 parts cubic nitre contain 42,35 of alkali, and 57,65 of the ſtrongeſt nitrous acid, equivalent to 78,33 of ſtandard nearly.

Of Common Salt. 1ſt. 100 parts pure marine alkali take up 88,81 of ſtrong muriat. acid, equivalent to 145,92 of ſtandard, and ſhould produce 188,81 of ſalt. 2d. 100 parts common ſalt contain nearly 53 of alkali, and 47 of ſtrong acid.

Of Ammoniacal Salts. Before proceeding to the analyſis of theſe, Mr. Kirwan examines the compoſition of his aerated volatile alkali, and by Dr. Prieſtley's experiments he calculates that 100 parts of this concrete ſalt contain nearly 44 of pure alkali, and 56 of fixed air.

Of Vitriolic Ammoniac. 1ſt. 100 parts of pure volatile alkali take up 227,7 of ſtandard vitriol. acid, and, including water, ſhould afford 364,6 of cryſtallized vitriol. ammoniac. 2d. 100 parts of vitriol. ammoniac contain 27,42 of mere alkali, 62,47 of ſtandard acid, and 10,11 of water.

Of Nitrous Ammoniac. 1ſt. 100 parts pure volatile alkali take up 316 of ſtrong nitrous acid, equivalent to 327,4 of ſtandard, and ſhould afford 416 of cryſtallized nitrous ammoniac. 2d. 100 parts nitrous ammoniac contain 24 of alkali, and 76 of the ſtrongeſt nitrous acid, equivalent to 78,75 of ſtandard.

Of Common Sal Ammoniac. 1ſt. 100 parts pure alkali take up 247,1 ſtandard muriatic acid, and ſhould produce 361 of cryſtallized ammoniac. 2d. 100 parts ſal ammoniac contain 27,62 of alkali, 68,49 ſtandard acid, and 3,89 water.

Of the Relation of Nitrous Acid to Calcareous Earth. 100 parts ſtandard nitrous acid take up 136 of white ſtatuary marble in fine powder. The loſs of air was nearly 45 per cent. This marble contained 3 per cent. of a mixture of argil and minute cryſtals.

If it contained no water (as is probable) the pure lime in 100 parts of it would be 52 parts.

Of the Relation of the Muriatic Acid to Calcareous Earth. 100 parts of marble ſaturate 86,5 of ſtandard marine acid. 100 parts of lime ſhould take up 104,72.

Of Vitriolic Selenite. 100 grs. ſtandard vitriol. acid take up 113,4 of marble; and 100 parts of marble require 88,17 of ſtandard acid. By the proportion of pure lime in the marble, 100 parts lime take up 169,55 of ſtandard acid. The ſelenite thus obtained, evaporated to dryneſs, contains in 100 grs. 329 pure earth, 55 ſtandard acid, and 12,1 water; but this is not accurate, as the argil muſt have taken part of the acid. Of dried ſelenite obtained by precipitating a nitrous ſolution of marble by tartar vitriolate, 100 grs. contain 34 of earth, 43 of ſtandard acid, and 23 of water.

Of Epſom Salt. 1ſt. 100 parts cryſtallized Epſom ſalt contain 17 of earth, 33 ſtandard acid, and 50 water. 2d. 100 parts pure magneſia take up 194 vitriolic acid, and ſhould afford 589 of cryſtallized Epſom ſalt.

Of the Relation of the Nitrous Acid to Magneſia. 100 parts pure magneſia take up 286 of the nitrous ſtandard.

Of the Relation of Marine Acid to Magneſia. 100 parts pure magneſia take up 215,8 of the muriatic ſtandard.

Of Alum. The proportion of its ingredients, diſcovered by decompoſition, was, in 100 parts alum, 29,37 of earth, 26,63 of acid whoſe ſpecific gravity is 1,7509, and 44 of water of cryſtallization. 100 parts calcined alum contain about 52,3 of earth, 35,2 of ſtandard acid, and 12,5 of water.

Of Vitriol of Iron. In 100 parts cryſtallized vitriol of iron, the proportion of ingredients is, iron 22,32, ſtandard acid 29,21, water united to the acid 9,47, water of cryſtallization 39. Hence, 100 parts iron require 130,85 of the vitriolic ſtandard for their ſolution.

Of the Quantity of real Acid in the different Standards. By real acid Mr. Kirwan underſtands the ſtrongeſt acid known to exiſt, whether in a ſeparate or combined ſtate.

TABLE I.

Of the Proportion of Acid abſorbed by different Baſes.

100 Parts.	Vitriolic Acid. Standard.	Nitrous Acid. Standard.	Marine Acid. Standard.	Vitriolic Acid. Real.	Nitrous Acid. Real.	Marine Acid. Real.
Pure Vegetable alkali -	92	120	115	82,1	88.3	59:3
Mineral alkali -	143	171	145,92	127,7	136	75,19
Volatile alkali -	227	327	247	202,6	240,4	127,25
Lime - -	124	258,5	104.72	110,6	190	53:91
Magneſia - -	194	286	215,8	173.2	210.33	111.2

TABLE II.

Of the Proportion of Baſis abſorbed by the different Acid Standards.

100 Parts.	Vegetable Alkali.	Mineral Alkali.	Volatile Alkali.	Lime.	Magneſia.
Vitriolic acid - - -	108.7	70	44	80,6	56,6
Nitrous acid - - -	83:33	58,4	30.58	38,4	34,9
Marine acid - - -	87	68.5	40.48	95.4	46.3

TABLE III.

Of the Proportion of Baſis abſorbed by the different Real Acids.

100 Parts.	Vegetable Alkali.	Mineral Alkali.	Volatile Alkali.	Lime.	Magneſia.
Vitriolic acid	121,8	78,3	49:3	90,4	57;7
Nitrous acid	113,2	73:5	41,2	52,6	47:6
Marine acid	168.6	133	78.5	185	89 9

TABLE IV.

Of the Proportion of Ingredients in different Salts.

100 Parts.	Alkali.	Water of cryſtallization.	Acid*.
Tartar vitriolate	55	——	45 equivalent to 50,49 ſtandard.
Nitre	46,15	——	53,85 equivalent to 55:7 ſtandard.
Salt of Sylvius	64,2	——	35,8 equivalent to 73 ſtandard.
Glauber's ſalt	24,16	41,3	34,54 ſtandard.
Cubic nitre	42,35	——	57,65 equivalent to 78,33 ſtandard.
Common ſalt	53	——	47 equivalent to 77,33 ſtandard.
Vitriolic ammoniac	27,42	10,11	62,47 ſtandard.
Nitrous ammoniac	24	——	76 equivalent to 78 ſtandard.
Common ſal ammoniac	27,62	3,89	68,49 ſtandard.
	Earth or Metal.		
Selenite	34	23	43 ſtandard.
Epſom	17	50	33 ſtandard.
Allum	29,37	44	26,63 containing 19,78 ſtandard.
Vitriol of iron	22.32	39	38,68 containing 29,21 ſtandard.

The remainder of the paper conſiſts of remarks on ſome of Mr. Morveau's exceptions to Mr. Kirwan's theory in his former paper; and of the application of the foregoing principles to miſcellaneous experiments. The experiments to which they are applied are thoſe of Meſſ. Berthollet, Morveau, and Woulfe.

Chemical Communications and Enquiries. By ROBERT PERCEVAL, *M. D. and M. R. I. A.*

Marine Acid.

FOUR pounds of decrepitated ſalt were decompoſed by two pounds of vitriolic acid (ſp. gr. 1,845) diluted with the ſame weight of water. By means of a tubulated receiver, the product was divided into three portions, the two firſt conſiſting each of 12 ounce meaſures, the laſt of 10. The ſpecific gravity of theſe portions was as follows:

1ſt portion	1,181
2d	1,119
3d	1,191

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* The acid here mentioned is ſometimes the ſtrongeſt, and ſometimes intermediate between the ſtrongeſt and ſtandard, but its ſtrength may always be known by its relation to the ſtandard.

On repeating the experiment, the reſult turned out ſomewhat different, the 1ſt and 2d portions being both ſtronger; this probably depended on the heat having been more moderate in the latter experiment, in conſequence of which leſs marine acid air was loſt than in the former.

Specific gravity,	1ſt portion -	1,193
	2d - -	1,126
	3d - -	1,191

The general concluſion is however the ſame, namely, that what firſt and laſt comes over in diſtillation is ſtronger than the intermediate portion, and the concluſion is confirmed by the reſult of two other experiments, the details of which, as reſembling thoſe deſcribed, need not be recited.

As marine acid air is more volatile than water, we find no difficulty in conceiving how the firſt portion of acid may be the moſt ſaturated; why the laſt portion ſhould be ſtronger than the intermediate is not ſo obviouſly to be accounted for; perhaps, towards the latter end of the proceſs, the vitriolic acid acts on the ſalt in a more concentrated ſtate. At firſt, I imagined that part of this acid paſſed in diſtillation, in conſequence of the increaſed heat, but on examining the laſt portions with a ſolution of nitrated terra ponderoſa, I found that no precipitate was produced but what was eaſily rediſſolved in diſtilled water, and which therefore I concluded did not indicate the preſence of vitriolic acid*.

Nitrous Acid.

In the diſtillation of nitrous acid, as in that of marine, the firſt portion is the heavieſt, but, as the diſtillation advances, the ſpecific gravity of the products appears uniformly to diminiſh. Two pounds of nitre were decompoſed by one of concentrated vitriolic acid; the product was divided into three portions, the two firſt conſiſting of 3 ounce meaſures each, the laſt of 2½; their ſpecific gravities were as follow,

1 - -	1,494
2 - -	1,485
3 - -	1,442

As the vitriolic acid in this proceſs is always in its moſt concentrated ſtate, the cauſe on which the increaſed ſpecific gravity of the laſt portion of marine acid ſeems to depend cannot here operate.

Volatile Alkali.

In diſtilling cauſtic volatile alkali, the firſt portions that paſs in diſtillation have the leaſt ſpecific gravity. In the proceſs for cauſtic volatile alkali, according to the Edinburgh Diſpenſatory, the firſt product, amounting to 1 lb. 100 grs. was found to be ,936 at the temperature 58; the ſecond product, weighing 1 lb. 1030 grs. at the ſame temperature, was ,960. Volatile alkali is always lighter than water, when perfectly cauſtic†. Alkaline air, as well as marine acid air, from its extreme volatility, ſeems diſpoſed to unite moſt copiouſly with the firſt portions of water. That theſe become lighter by uniting with it ſeems to depend on the elaſticity of the alkaline air, which the attractive force that unites it to water is incapable of entirely repreſſing.

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* On adding a ſolution of nitrated terra ponderoſa to pure and ſtrong nitrous or marine acid, I have obſerved an eaſily ſoluble precipitate to be produced. Q. Is this an earthly ſalt with exceſs of acid, or does the acid deprive the ſalt of the water of its ſolution?

† This is not the caſe with the aerated volatile alkali; this liquor, obtained according to the ſame diſpenſatory, was found, in two experiments, to be 1,042.

Vitriolic Acid.

We are informed by the moſt reſpectable authorities that vitriolic acid has been obtained ſo ſtrong as to be more than twice as heavy as water, but by what proceſs I remain ignorant. I have, though perhaps miſtakenly, ſuſpected that ſuch acid was not pure, but owed its great weight to ſelenite, vitriolated lead or vitriolated alkali, which it contained. I found the ſpecific gravity of common vitriolic acid increaſed from 1,845 to 1,892, by diſſolving in 9 ounce meaſures of it 960 grs. of vitriolated vegetable alkali. Six pounds of common vitriolic acid (ſp. gr. 1,842) were diſtilled until 3134 grs. came over; what remained was concentrated to 1,849. Four pounds of this concentrated acid were heated until the bottom of the retort and the liquor itſelf appeared red, and were expoſed to this heat for above half an hour, during which time copious white ſuffocating fumes paſſed in great abundance; what remained in the retort weighed 2 lbs. 1840 grs. and was concentrated to 1,852. What came over appeared to be as ſtrong as what was at firſt put into the retort. In theſe and other ſimilar experiments, as is well obſerved by Mr. Kirwan, the acid in the retort depoſits a quantity of white powder, which appears to be gypſeous; this it lets fall in ſtill greater quantity when diluted with water. What paſſed over in the laſt mentioned experiment, although very ſtrong, was found to remain clear after dilution. Willing therefore to try what degree of concentration this pure acid would admit, I ſubjected it, together with the product of many ſimilar proceſſes, to the action of a ſtrong fire.

	Grs.
Theſe products weighed - - - -	40380
Came over - - - - -	10680
Remain in retort - - - -	29240
Loſt in vapour - - - - -	460
Temperature 50. Specific gravity of what came over was -	1,394
Specific gravity of what remained in retort, and which bore dilution with diſtilled water without having its tranſparency in the leaſt diſturbed was	1,846

Account of a Chamber Lamp-Furnace. By Robert Perceval, *M. D. and M. R. I. A.*

THIS conſiſts of a cylindrical body, ſurmounted by a conical laboratory for holding veſſels. The lamp contained within the cylinder is one of Argand's conſtruction, and is made to riſe and fall according to the required diſtance from the veſſels. A ſlider in the ſide of the cylinder ſerves for trimming the lamp and regulating the heat. For the detail of the contrivance we refer to the paper and figure accompanying it, which, however, is ſcarcely intelligible but to a practiſed workman.

Extract of a Letter from the Rev. Charles Perceval to Robert Perceval, M. D.

THE ſubject of this extract is the caſe of a peculiar affection in the eyes of a child in the charter-ſchool of Dunkerrin, thus related.

Jane Bern, a girl aged eleven years or thereabouts, low in ſtature, is of an healthy appearance and ſtrong make; her eyes are conſtructed in an extraordinary manner; their motion, inſtead of a regular horizontal one, from left to right, and vice verſâ, is tremulous in all directions, and partly perpendicular, with a prominent motion of the globe of the eye: what lateral motion the eye is capable of is ſhort, interrupted, and gives that organ the appearance of being bound by ligaments, from which it ſtruggles to get free. The child cannot eaſily look upwards, or ſee any object placed above her eyes; and when ſhe reads, which ſhe does without any heſitation or difficulty, ſhe reads perpendicularly from the bottom upwards, and holds the book accordingly. The whole globe of the eye is of a reddiſh caſt, the white is ſtreaked with ſtriæ of a fainter red; the iris is of an uniform deep red approaching to brown; both her eyes are weak and watery, and, when turned from the light, glow with a more fiery and vivid colour than when expoſed to it. Though ſhe reads very well, ſhe cannot write, neither do I find ſhe can work, knit, or ſpin. She ſeems poſſeſſed of a moderate plain underſtanding, and anſwered very well in the Church Catechiſm and Doctor Mann's Expoſition of it. She has remarkable fine hair, of the colour of flax, but conſiderably whiter. The miſtreſs of the ſchool informed me that the child was ſent to her from a nurſery in the county of Longford in the North of Ireland. I was not informed whether any more of her family had theſe peculiarities, but mean to make enquiry when I next happen to travel through that part of the country where the girl is and ſhall let you know it.

Deſcription of a Portable Barometer. By the Rev. GILBERT AUSTIN, *M. A. and M. R. I. A.*

THE body of the barometer conſiſts of an upper box *a*, and a lower *b*. (See Plate XVII. Fig. 3.) On the upper is the baſon of mercury *f*, in which the tube *c* with the attached thermometer are immerſed. In the lower is the bag *e*, cloſely glued to the upper, and communicating with the baſon by the perforation *g*, which is ſhut at pleaſure by the ſtop cock *h*. By means of this perforation, the mercury in the baſon may be always kept at the ſame level; for, when it is below the level, by preſſing with the thumb through the hole in the looſe piece *n*, the mercury in the bag is reſtored to the baſon. A ſmall air hole *o* is in the top of the upper box, which is opened or ſhut by a ſmall ivory peg or ſtopper.

To render the barometer portable, firſt cloſe the air hole, then invert the barometer, preſs the bag ſo as to fill compleatly the cavity of the baſon, unſcrew a ſmall ſteel pin *x*, which paſſes from the outſide of the upper box into the bottom of the baſon, and force the mercury out of the bag until it appears in this hole; the air being then perfectly excluded, ſhut the ſtop cock by turning it by the ſquare *q* with its key one quarter or one half round, and ſcrew again into its place the ſteel ſcrew.

To make it ready for obſervation, hold it inclined, open the ſtop cock firſt, then the air hole, and let it down gently to its perpendicular direction.

Among other advantages of this barometer, the ſurface in the baſon is more accurately determined, than can be done by floating gages, and there is no waſte of mercury.

Obſervations on the Variation of the Needle. By THOMAS HARDING, *M.R.I.A.*

FOR the laſt nineteen years this writer has paid a ſerious attention to the variation of the needle, and the reſult of his obſervations is, that the change in the variation is uniform at Dublin; and that, from the year 1657, when there was no variation, it has varied at the rate of twelve minutes twenty ſeconds annually. From 1657 to this time, (May, 1791) it has been increaſing, being now 27 degrees 23 minutes weſterly. By Mr. Churchman's* chart it ought to be only 19 degrees.

For proof that the change in the variation is uniform at Dublin, reference is made to former obſervations. In 1580, by Mr. Burrow's obſervation, the variation was 11 degrees 15 minutes eaſt of the meridian of Greenwich: by Mr. Gunter's, in 1622, ſix degrees eaſterly; by Mr. Gellibrand's, 1634, four degrees five minutes eaſterly. In 1657, according to the Down ſurvey, there was no variation. In 1745, according to Mr. Roger Kendrick, 18 degrees weſt. In 1751, according to Mr. Gibſon, 19 degrees weſt. In 1772, by this writer's obſervation, 23 degrees 30 minutes weſt. In 1786, May 26, 26° 21′ weſt. In 1790, Sept. 27, 27° 15′ weſt.

Mr. Gibſon publiſhed his account in 1751, and in the year following he affixed the ſame variation to a map, now in the poſſeſſion of Mr. Deane, which proves that he was unacquainted with the annual change.

From the above-mentioned obſervations it appears, that the change in the variation between the years 1657 and 1745 was, upon an average, 12 minutes 16 ſeconds annually: between 1751 and 1657, 12 minutes 8 ſeconds nearly: between 1786 and 1657, 12 minutes 16 ſeconds nearly: and between 1790 and 1657, 12 minutes 18 ſeconds nearly.

By comparing the intermediate dates, the reſults will be nearly the ſame. Between 1751 and 1745 it is indeed only ten minutes; but in this inſtance it is probable that the variation was not very accurately taken. Between 1722 and 1751 it is twelve minutes fifty-one ſeconds; and here it is evident that Mr. Gibſon ſuppoſed the variation the ſame for ſeveral years. Between 1786 and 1772, it is twelve minutes thirteen ſeconds nearly. Between 1790 and 1786, it is twelve minutes twenty-ſeven ſeconds. The mean deduced from theſe and ſeveral other obſervations is twelve minutes twenty ſeconds. Hence, to find the year when there was no variation, ſay, as 12′ 20″ : 1 *y.* : : 27° 15′ : 132½ years, and from 1790 deduct 132½, there remains 1657½, the preciſe time when there was no variation here.

In the ſame manner the variation, in the year 1751, is found to be 19° 14′, one fourth of a degree more than by Gibſon's account; from which it appears, that the variation in 1750, not in 1751, was nineteen degrees. Mr. Kendrick's account may be proved by the ſame analogy, as 12′ 20″ : 1 *y.* : : 18° 87½, ſo that early in the year 1745, the variation muſt have been eighteen degrees weſterly.

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* Mr. Churchman is a very ingenious man of Philadelphia, who, under the idea of finding the longitude by means of the variations of the needle, has drawn a chart, and written obſervations, which, though they may not eſtabliſh his point, deſerve the attention of philoſophical enquirers.

Mr. Harding from hence obſerves, how neceſſary it is that maps, whether of a public or private nature, ſhould be examined with care and attention. For if the magnetic meridian is drawn, and the variation expreſſed, every boundary may be defined with the greateſt eaſe. But this he conſiders only as a ſecondary point; the moſt material thing is by obſerving the variations in every part of the world, to lay a foundation for the diſcovery of the longitude: for certainly, ſays he, were the magnetic laws univerſally known, the longitude could be more readily aſcertained by them, than by any other means.

Anſwer to Mr. Churchman's Queries.

Variation at Dublin, September the 27th, 1790	27° 15′ Weſt.
Latitude of Dublin	53° 20′ North.
Longitude, weſt of Greenwich, in time	24′ 24″ Weſt.

Deſcription of an Inſtrument for performing the Operation of Trepanning the Skull, with more Eaſe, Safety and Expedition, than thoſe now in general Uſe. By Samuel Croker King, *Eſq. Member of the Royal Coll. of Surgeons in Ireland, and M. R. I. A.*

AFTER an hiſtorical account of the uſe of the two inſtruments called the Trepan and Trephine, in theſe kingdoms, with obſervations on the defects of both, the writer thus deſcribes that which he recommends as an improvement on both. This inſtrument is compoſed of a crown or ſaw made in the uſual form, and about an inch and an half from the crown is fixed a ſpindle four inches and an half long, which is received into a barrel or canula of four inches in length; to the top of the ſpindle, which is ſquare above the canula, is applied a handle or winch, with a nut ſcrewed on the ſpindle to keep the handle on; at the lower part of the canula or barrel is a flat rim, projecting about a quarter of an inch, on which the left hand, which graſps the canula, reſts, to prevent it from ſlipping down on the part of the inſtrument below it, which is turned by the handle above; the crown has a center-pin, as in the other inſtruments, with a key to remove it when the ſulcus is deep enough to admit it to be taken away. Though with this the operation may with great eaſe and ſafety be entirely completed, yet to accommodate thoſe who wiſh to finiſh with the trephine, the upper part of the barrel or canula is made ſquare to fit into a wooden handle; upon applying this handle, inſtead of the winch, the inſtrument is converted into a trephine; in this wooden handle is a ſquare opening fitted to the ſquare part of the ſpindle, and faſtened by the ſame nut.

It will be requiſite to have two or three crowns of different ſizes, that the operator may chuſe that which will beſt ſuit the circumſtances of the caſe; as to the form of the crowns, modern practitioners have ſo differed about them, that every ſurgeon muſt be left to his own choice. For my part I ſhould prefer thoſe as the beſt and ſafeſt which are neither too conical nor too cylindrical, but between both extremes; and, as Mr. Cheſelden* has adviſed, the cavity in the inſide to enlarge in the ſame manner the outſide does, to prevent the piece of bone to be taken out from being wedged in the cavity, and to allow the crown or ſaw to be inclined to one ſide or to the other, as occaſion may require, during the operation.

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* Cheſelden's Obſervations on Le Dran, page 447.

EXPLANATION of Plate XVII. Fig. 3.

a	The crown or ſaw.
bb	The ſpindle to which the ſaw is faſtened. Note, the ſpindle is to be made ſmaller from each end to the middle, that it may not touch the barrel but at the upper and lower parts, to prevent too much friction in turning.
c c	The canula or barrel into which the ſpindle is introduced.
d	The lower part of the canula which projects ſomething above a quarter of an inch, on which the left hand is reſted.
e e	The handle, with a ſquare opening to fit the end of the ſpindle.
f	The knob of the handle, which ſhould be made of ivory.
g	The nut to ſcrew on the end of the ſpindle to keep the handle on.
h	The end of the canula, formed ſquare to fit the wooden handle when uſed as a trephine.
i i	The wooden handle fitted to receive the canula and ſpindle; when uſed as a trephine, the upper ſide is counter-ſunk to admit the nut.
k	The center-pin of the crown or ſaw.
l	The key, one end of which is made to fit the center-pin, and the other, which is forked, to fit the cavity in the top of the nut.

Deſcription of a ſelf-regiſtering Barometer. By the Rev. Arthur M'Gwire.

THE tube is fixed in a circular piece of wood H H, (See Plate XVII. Fig. 4.) of a ſufficient ſize to make the barometer float in the baſon at its proper height, and it is kept perpendicular by two ſemicircular parts of a tube F F. D is a pencil ſliding into a tube, whoſe center is fixed to the cylinder of the barometer, at the point where the mercury ſtands when at 29½: and on the other ſide is E, a vernier, to ſubdivide the diviſion on the ſcale B C. A A A A is a paper marking the hours, and moved horizontally by clock-work, which preſſing againſt the pencil, points the height of the mercury at any time. x is a mark in the tube of the barometer, which ſhews the depth at which the barometer floats, when the mercury ſtands at 29½. Suppoſing the mercury to deſcend in the barometer one inch, it will riſe in the tube of the reſervoir an inch from N to O, and the barometer will float higher by an inch, ſuppoſing the tubes of the barometer and the reſervoir to contain equal quantities in equal ſpaces: but as that part of the barometer which was above the ſurface of the mercury in the reſervoir, when its height in the tube was 29½, is become lighter in proportion as the mercury left the cylinder, ſo there will be a portion of the tube of the barometer from under the ſurface of the mercury in the reſervoir, and conſequently the barometer will float higher than one inch in proportion to its decreaſe of weight, and the x will be above the ſurface o; ſo that the vernier will have moved more than one inch, and the diviſions on the ſcale B C will be increaſed.

A Method of cutting very fine Screws, and Screws of two or more Threads, &c. By the Rev. Gilbert Austin, *A.M. M.R.I.A.*

AS this paper can intereſt workmen alone, we ſhall paſs it over.

An

Fig. 1.

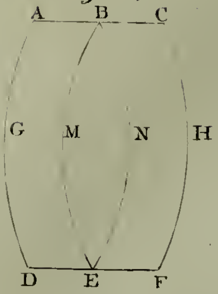


Fig. 2.

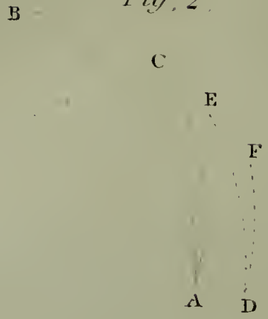


Fig 3

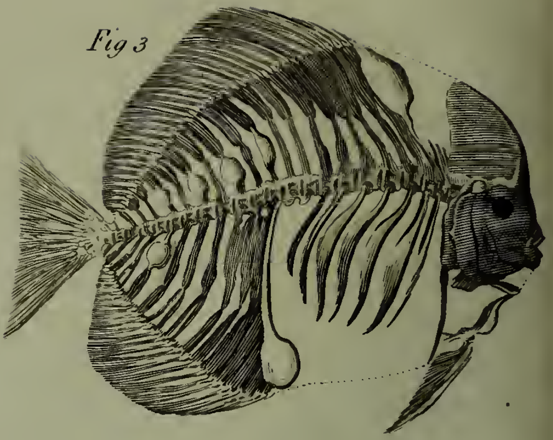


Fig 5

$\frac{2}{9}$ of the Original size

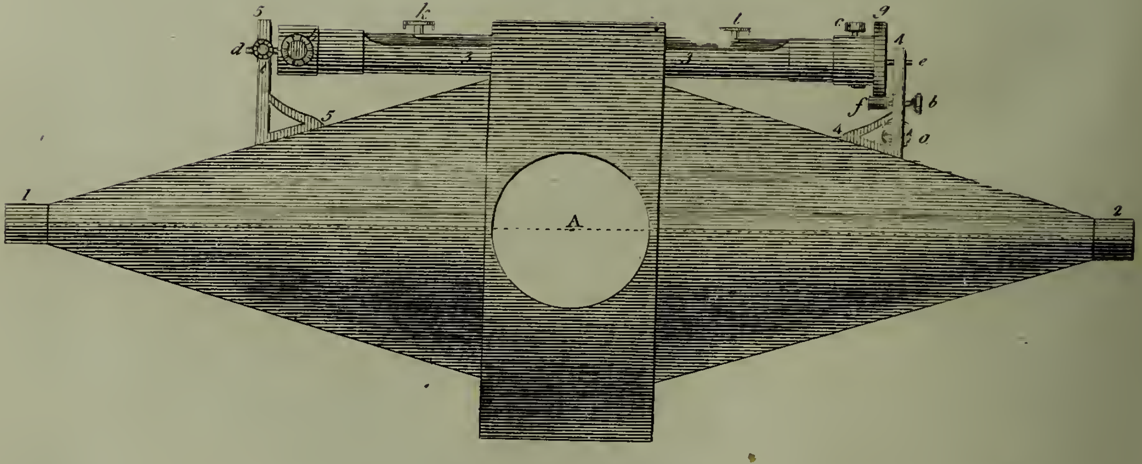
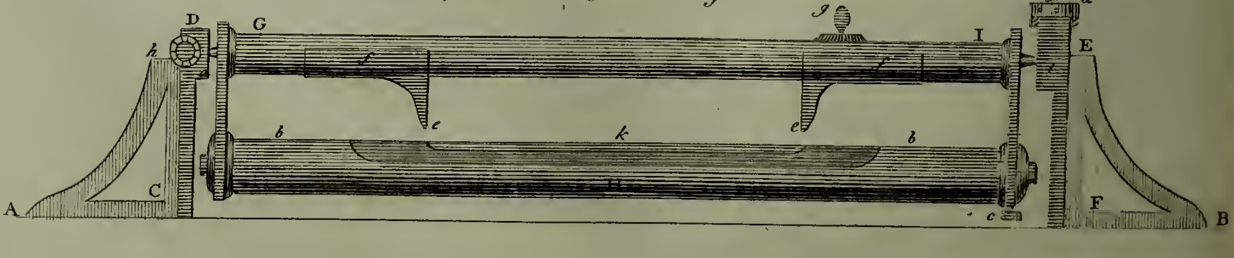


Fig 6 1/3 of the Original size



An Attempt to determine with Preciſion ſuch Injuries of the Head as neceſſarily require the Operation of the Trephine. By SYLVESTER O'HALLORAN, *Eſq. M.R.I.A. &c.*

THE obſervations in this paper are arranged under two articles---fractures of the cranium, and depoſits on the ſurface of the brain or on its membranes. Three caſes are firſt given of fractured ſkulls cured without trepanning; and then two more, in which ſymptoms occurring many days after the fracture, were removed by the operation. In the latter, the internal table of the ſkull was found ſplintered. It is the occurrence of theſe ſupervening ſymptoms of drowſineſs, coma, and convulſions, that ſeems to him the proper guide for the operation in ſimple fractures. In wounds of the ſkull with an inciſive inſtrument, he thinks the operation is never warrantable. Fractures with depreſſion require the operation *in the firſt inſtance.* This rule is illuſtrated by ſome caſes; yet others are adduced in which, from the efforts of nature, it ſucceeded after conſiderable delay.

He next proceeds to depoſits on the brain. The ſymptoms of matter forming under the ſkull commence from the 8th to the 15th day, and are ſickneſs, head-ach, fever, and rigor, paleneſs of the wound, a thin diſcharge, and detachment of the pericranium. In theſe caſes, the trepan gives the only poſſible chance, though a very ſmall one; it ſhould therefore be reſorted to, and uſed freely. But with reſpect to concuſſions, though ſometimes they prove mortal, yet the writer thinks them no proper object for the operation; and he always attributes the ſtupor *immediately* following the accident to concuſſion only, and not extravaſation.

The paper concludes with the following propoſitions.

1. That many fractures of the ſkull do not require the application of the trephine.
2. That ſome apparently ſlight fractures do abſolutely require its application; in ſuch caſes the inner table of the ſkull is generally more hurt than the outer, and bad ſymptoms do not ariſe till towards the end of a fortnight after the injury.
3. That fractures with depreſſion require the application of the trephine, and that from ſuch there have been ſome ſurpriſing recoveries.
4. That depoſites of matter on the membranes or ſurface of the brain require the trephine, though it ſeldom proves ſucceſsful.
5. That concuſſion of the brain, characteriſed by *immediate ſtupor and inſenſibility,* does not require the trephine, unleſs accompanied with evident depreſſion of the ſkull or extravaſations, neither of which produces bad ſymptoms for ſome days after the accident which has given riſe to them.

Demonſtration of Newton's Theorem for the Correction of ſperical Errors in the Object Glaſſes of Teleſcopes. By *the Rev.* MATTHEW YOUNG, *D.D. &c.*

ADEB, GFCB, are two ſimilar concavo-convex lenſes, (See Plate XVIII. Fig. 1.) D being the diameter of the convex ſides, AGD, CHF, and the diameter of the concave ſides is to D as the cube root of K^2-KI to the cube root of $RK-RI$; when ſine of incidence : ſine of refraction of glaſs into air : : I : R, and : : K : R out of water into air: according to Newton in the editions of the optics, in Clarke's Latin tranſlation, and Horſeley's edition. Yet there muſt without doubt be an error in the text, for $K^2-KI : RK-RI :: K : R$, and it cannot be ſuppoſed that Newton would have given ſo complex a form, when a very ſimple one might upon this principle have been uſed.

Suppoſing y to be the ſemi-aperture of the lens, Newton has demonſtrated, that the lateral aberration at the focus, ariſing from the ſphericalneſs of the figure, of parallel rays falling on the plane ſide of a plano convex lens, is equal to $\frac{R^2 y^3}{2I^2 D^2}$, which divided by $\frac{RD}{R-I}$, the diſtance of the focus from the center of the lens, gives $\frac{R^2-RI}{2I^2-D^3} \times y^3$ for the angle which the lateral aberration at the focus ſubtends at the center of the ſurface. Now when the ray paſſes from the glaſs into the included water, and from the water into the glaſs, the refractions, and conſequently the ſpherical aberrations, are contrary to thoſe at the firſt and laſt ſurface; and therefore, that all aberration ſhould vaniſh, the lateral aberrations from glaſs into air, and from glaſs into water, (as being the principal and nearly equal to thoſe from air into glaſs, and from water into glaſs) ſhould ſubtend equal angles at the common center of the ſpherical ſurfaces. Therefore ſuppoſing the rays in paſſing from the glaſs into the water to fall parallel on the water, the angle which the lateral aberration of the rays at the focus ſubtends at the center of the refracting ſurface, will equal $\frac{K^2-KI}{2I^2 d^3} \times y^3$, which being made equal to $\frac{R^2-RI}{2I^2 D^3} \times y^3$, we have $d^3 : D^3 :: K^2-KI : R^2-RI$, and therefore we ſhould read R^2 inſtead of RK as it now ſtands in Newton's text.

Account of a fiſtulous Opening in the Stomach. *By* GEORGE BURROWES, *M.D. M.R.I.A.*

ALTHOUGH wounds of the ſtomach are uſually reckoned among the moſt fatal, yet there are various inſtances upon record in which they have remained uncloſed externally, without any irremediable inconvenience. The preſent paper adds one to the number. Its ſubject was an inferior officer in the Eaſt-India Company's navy, who in a voyage received a wound from a blunt-pointed wooden inſtrument, between the cartilage of the eighth rib on the right ſide, and the navel, penetrating the ſtomach. Much fever and inflammation ſucceeded, and continued a long time. When they had ſubſided, an opening remained, through which, when the tent was withdrawn, a whitiſh fluid flowed out. Its ſides turned in, and could not be brought to unite. The man ever after kept the orifice plugged up, never withdrawing the plug but to gratify curioſity, or place a new one. The opening was about a third of an inch in diameter. He had lived twenty-ſeven years in this ſtate, being extremely drunken and diſſipated in his habits, when Dr. Burrowes firſt ſaw him, then aged 65. He then taught French in Dublin. Notwithſtanding he had loſt all his teeth with the ſcurvy, he eat with a good appetite and digeſtion. The liquids he took, in part eſcaped through the opening when he withdrew the plug; and when his ſtomach was empty, a ſweet whitiſh fluid adhered to the plug. He had no pain, and no food diſagreed with him. Having been reduced to poverty by his intemperance, and ſuffering much from hardſhip, he gradually declined and died.

On examining the body, the wound was found to have penetrated the ſtomach in the center of the greater curvature; and from the adheſions of the liver, colon, and integuments, a large ſtricture was formed, which gave the ſtomach the appearance of a double bag, with the opening in the middle. The duodenum was enlarged beyond the ſize of the colon, and ſeemed to have performed ſome of the functions of a ſecond ſtomach. The colon was firmly attached to the ſtomach by a ligamentous ſubſtance. All the other viſcera were ſound and natural.

Caſe of an enlarged Spleen. By GEORGE BURROWES, *M.D. M.R.I.A.*

"ON the 4th of April, 1792, a man aged about forty-four, who had that morning walked ſeveral miles from the country, applied for admittance at the Hoſpital of the Houſe of Induſtry. He ſaid he had laboured under dropſy for ſome months, during which time the abdomen had increaſed to the ſize it then was, which was equal to that of a woman in the ninth month of pregnancy. His eyes were ſuffuſed with yellow, but his legs were not then, nor had they ever been, ſwelled. The abdomen was examined by ſome of the young gentlemen, my pupils, who thought they could perceive an evident fluctuation. He was put into the chronic ward, and ſome opening medicine ordered to be taken the following day (the 5th): this operated well; but on the next day (the 6th) he was ſeized with ſevere vomiting and head-ach, which prevented any examination of the ſwelling, being ſuppoſed to ariſe from fatigue, change of air, diet, &c. The vomiting continuing on the 7th, he was removed to the fever ward, where he could be better attended and more regularly viſited. Not having any apprehenſion of contagion, in the ſtate I ſuppoſed the fluids to be in, the effervescing draughts were preſcribed him, and ſome wine. When I viſited him on the 8th, his pulſe was extremely quick and feeble, his ſkin hot, and tongue white, and I was informed that he had raved at times during the night. Bliſters were then applied to the legs, an injection ordered, and the wine increaſed. The vomiting ſtill returned at intervals. On the 9th, all the ſymptoms became much more violent, and ſlight hiccough diſturbed him now and then. The wine was again increaſed, being the only thing his ſtomach would bear. On the 10th I found him in a ſtate nearly approaching to coma, with conſtant ſingultus. Attempts were made to rouſe him by further ſtimulating applications, but in vain; and he died that evening, the ſixth from his admiſſion, and the fourth from the attack of vomiting.

"I examined the body the morning after his deceaſe. From the circumſcribed appearance of the tumified abdomen, I ſuppoſed the water might be contained in a cyſt (a circumſtance, I believe, ſeldom met with in men) as it much reſembled a diſeaſe very familiar to me in the hoſpital, I mean ovarium dropſy. On ſtriking the tumour on one ſide, while I kept my hand fixed on the other, I had no doubt of feeling a fluctuation; but when I preſſed hard on the linea alba, or center of the abdomen, I was greatly ſurpriſed to find a ridge reaching from the ſternum to the pelvis. I then opened the cavity, and beheld the ſtomach and inteſtines all thrown completely to the right ſide, much diſtended with air, while the whole left ſide was filled up with the ſpleen, enlarged to an enormous ſize, and occupying the entire half of the cavity, from the diaphragm, which projected into the thorax, to the pelvis; it was neither diſcoloured nor indurated, but natural in every reſpect except ſize. The veſſels were not more than a third larger than in an ordinary ſized ſpleen.

"When this enormous viſcus was taken out, it meaſured fourteen inches and a half long, and weighed *eleven* pounds thirteen ounces. I need hardly mention that the uſual length is about four inches, and the weight ſix or eight ounces. The liver was ſomewhat diſcoloured and diſeaſed, but not a ſpoonful of water was contained in the abdomen.

" The evenneſs and ſoft texture of the viſcus on one ſide, and the equability of the other from the diſtended inteſtines, joined to the facility with which ſuch bodies would convey the *ictus*, when ſtruck on the left ſide (the uſual method, it being done by the operator's right hand) might have deceived even an experienced ſurgeon; and had a perſon with ſuch a diſeaſe been tapped, the trocar muſt have inevitably been plunged into the viſcus, and death (from hæmorrhage) have enſued.*

" The ſtomach was changed in poſition as well as ſcite, lying more obliquely than horizontally; and ſo compreſſed was it between the liver and this enlarged ſpleen, that it required very conſiderable force to diſtend it. That part of the colon which is tied down by a ligament, in conſequence of the great preſſure, had its diameter much leſſened, and the thickneſs of its coats very conſiderably increaſed."

POLITE LITERATURE.†

A Diſſertation on a Paſſage in the ſixth Iliad of Homer. By the Rev. Edward Ledwich, *L. L. B. M. R. I. A. and F. S. A. Lond. and Edinb.*

THE paſſage is that in which Prætus is ſaid to have ſent letters in a folded tablet, by Bellerophon, to Jobates king of Lycia. Contrary to the opinion of various critics, Mr. Ledwich maintains that this is a real proof of the uſe of literal writing in the time of Homer.

Eſſay on a Syſtem of National Education, adapted to Ireland. By Stephen Dickson, *State Phyſician, &c. &c.*

THIS was a prize Memoir. Its ſeveral heads are, Of education as it concerns health. Of education as it promotes morality. Of education as it relates to inſtruction in the knowledge requiſite for the ſeveral departments of ſociety; viz. 1. Of the elementary inſtruction of the children of the labouring poor. 2. Of inſtruction in agriculture. 3. Of inſtruction in mining. 4. Of inſtruction in manufactures. 5. Of inſtruction in profeſſional and polite literature.

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* Such a circumſtance did once happen in Edinburgh, and the wounded ſpleen is exhibited by Dr. Monro in his lectures.

† As this claſs of papers does not come within the propoſed ſubjects of our work, we ſhall henceforth do little more than announce the titles of ſuch of them as are contained in the volumes which compoſe our Memoirs.

ANTIQUITIES.

Eſſay on the Riſe and Progreſs of Gardening in Ireland. By JOSEPH C. WALKER, *M.R.I.A. &c. &c.*

FROM this eſſay it only appears that Ireland has followed at a diſtance the taſte of gardening, which at different periods has prevailed in England.

Obſervations on the Romantic Hiſtory of Ireland. By the Rev. EDWARD LEDWICH, *&c. &c.*

THIS writer, who is an unbeliever in the wonderful tales of Keating, and the early Iriſh hiſtorians, traces the ſpirit of fabling to the Arabian fictions, introduced into Europe by the Saracens, and ſpread through Spain and other countries. It is to the connexion of Ireland with Armorica, Wales, and Cornwall, that he attributes the immediate introduction of romance into the Iriſh records.

Deſcription of an ancient Iriſh Inſtrument, &c. &c.

THIS is a round hollow tapering piece of wood, ſix feet four inches long, wrapped round with a ſpiral braſs fillet, which Mr. Ouſley ſuppoſes to have been a ſpecies of trumpet. It was found buried deep in a turf-bog.

Letter from William Moleſworth, Eſq. concerning ſome Golden Antique Inſtruments found in a Bog in the County of Armagh.

THESE are incapable of deſcription; and as no probable uſe or purpoſe is aſſigned to them, we ſhall paſs them over.

Caoinan: or ſome Account of the ancient Iriſh Lamentations. By WILLIAM BEAUFORD, *A.M.*

THE noted Iriſh cry, conſiſting of a mournful recitation of the qualities of the deceaſed, with interrogations, and a chorus of inarticulate howlings, is here given in the form of a muſical compoſition, with words and notes. This example is probably a production of the 15th century.

Memoirs of the Literary and Philoſophical Society of Mancheſter.

THIS ſociety, originally a private aſſociation of gentlemen in the town of Mancheſter, formed themſelves ſeveral years ago into a body, and publiſhed their firſt and ſecond volumes in 1785; and a third in 1790. Theſe, as well as the preſent

ſent, as the title imports, were compoſed of ſubjects partly literary, partly relative to the various branches of philoſophy. No formal diviſion of the two claſſes was made, but they were intermixed as they came to hand for publication. We have already mentioned, that our plan only properly compriſing ſcience and art, we mean to do little more than juſt enumerate the papers on literature, which are contained in mixed publications like the preſent.

Reaſons for ſuppoſing that Lakes have been more numerous than they are at preſent; with an Attempt to aſſign the Cauſes whereby they have been defaced. By J. Gough, *of Kendal.*

THAT theory of the earth which ſuppoſes its preſent ſurface to have ariſen by ſubterraneous convulſions from the bottom of the deep, ſeems neceſſarily to require frequent lakes, which are depreſſions or chaſms in the ground where the waters of the neighbourhood are collected. Why then are there ſo few? The writer endeavours to anſwer this objection by enquiring, 1. what means may be employed by nature for filling up lakes; and, 2. whether proofs of ſuch alterations actually exiſt. With reſpect to the firſt, *vegetation* is a proceſs which nature is conſtantly carrying on, and by means of which ſhe cloaths the ſides and bottoms of lakes wherever the temperature is not too cold to ſuffer plants to grow. The remains of decayed vegetables gradually accumulated, and preſerved by water from entire decompoſition, will, after the lapſe of generations, fill up theſe cavities, and convert them to ſolid land. By this proceſs, the flat marſhes which furniſh peat for fuel to ſo many of the northern countries, have probably been formed. Where the water was too deep to admit of the growth of vegetables, pools are ſtill left, or dangerous bogs covered with a thin cruſt of aquatic plants. Peat is compoſed of intertwiſted fibres, mixed with a light friable earth, the product of decompoſed leaves, &c. In theſe bogs trees are often diſcovered, with leaves, and other extraneous matters, perfectly reſembling the refuſe of a river flowing through a woody country. Theſe ſubſtances were probably brought into the lakes by inundations after heavy rains, or have fallen in from the banks where they grew. If this is a true account of the formation of bogs, lakes muſt once have exiſted in every part of the globe.

Another reſource of nature is the diſpoſition of all the rocky ſtrata of the earth to be crumbled and broken to pieces by the action of the air; an action ſufficiently perceived in the channels of mountain torrents, which are dry during ſummer, and which becoming thus looſened, are ſwept by the next floods and worn to a great depth. Now, this proceſs would equally take place on the banks and ſides of lakes, which thus gradually falling in, would fill up the margins and form little iſlands. At the ſame time, the channels ſerving for the outlets of mountain lakes, wearing deeper and deeper, would drain off more and more of the waters of the lake, and at length, in certain ſituations, lay them quite dry.

As to the ſecond conſideration, that of the actual exiſtence of ſuch transformed lakes, the writer aſſerts that many vallies among the hills of the north of England preſent appearances perfectly correſponding with theſe ideas; particularly the *coves,* which ſeem ſcooped out of the ſides of ſeveral hills, the entrance to which is always a narrow paſs between two banks; and ſome more extenſive vallies, where the natural ſtrata of the country are buried under deep beds of ſand and gravel.

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An Argument againſt the Doctrine of Materialiſm, addreſſed to Thomas Cooper, Eſq. By JOHN FERRIAR, *M. D.*

THE materialiſts deny the neceſſity of any thing more than the viſible ſtructure of the brain, to produce the act of thinking in conſequence of perception; but the contrary ſeems probable to this writer, from the facts in medical hiſtory, which ſhew, that at different times every part of the ſtructure has been deſtroyed or greatly injured, without impeding the proceſs of thought. It is otherwiſe in the organs of ſenſe, for when thoſe parts of the brain from whence the nerves ſupplying ſuch organs originate, are injured, the ſenſes proportionally ſuffer. A relation of ſome of the moſt remarkable facts in authors which prove theſe poſitions, is the ſubſtance of the preſent paper. Thoſe which record the deſtruction of the ſuperior and lateral parts of the cerebrum are firſt given. They are ſucceeded by accounts of depravation of the cerebellum; and next, by thoſe of injuries of the baſis of the brain; and ſome caſes of general diminution or alteration of the ſubſtance of the brain, conclude the quotations. The inference drawn from the whole is, that as no part of the brain ſeems eſſentially neceſſary to the exiſtence of the intellectual faculties, ſomething more than the diſcernible organization muſt be requiſite to produce the phænomena of thinking.

Comments on Sterne. By JOHN FERRIAR, *M. D.*

THESE philological comments point out various ſources from whence the celebrated writer borrowed his thoughts and expreſſions.

An Account of, and Obſervations on, different Blue Colours, produced from the Mother Water of Soda Phoſphorata, &c. By Mr. THOMAS WILLIS, *of London.*

MR. WILLIS obſerving that the mother-water ſuffered to run to waſte, after the extraction of all the cryſtals of ſoda phoſphorata, appeared of a blueiſh colour on the contiguous ſtones, was induced to ſubject it to experiment. To ſome of this water he added a ſolution of common alum and martial vitriol; it threw down a fine blue precipitate. On ſubſtituting roche to common alum, a much paler precipitate was produced. Both theſe colours were given to a painter in water-colours, who found them too ſpungy. In order to avoid this effect, a precipitate was made with martial ſolution alone; but its colour was leſs beautiful than the firſt. In order to examine whence the colouring matter proceeded, various experiments were tried. From theſe it appeared, that from the mother-water produced from the combination of phoſphoric acid and mineral alkali, a blue colour is always obtained by means of a martial ſolution; and that from the mother-water of ſal ſoda it is uncertain, and what is produced is of a pale colour. The mother-water of tartarized natron will alſo ſometimes yield a Pruſſian blue, but not always, and it is commonly pale; whereas that with phoſphorated alkaline mother-waters is of a deep blue, except in the inſtance of roche alum being employed. The acid of phoſphorus yields no blue colour with the precipitating liquors; it ſtill remains therefore to account for its production from the combination abovementioned. The phoſphoric acid was obtained from bones burned to perfect whiteneſs.

On the Impreſſion of Reality attending Dramatic Repreſentations. By J. AIKIN, *M. D.*

IT is the purpoſe of this writer to ſhew, in oppoſition to the opinion of Dr. Johnſon, that the impreſſion with which we view a dramatic ſcene, or, indeed, ſcenes of fiction in general, is preciſely the ſame with that derived from a real one, only differing in degree of intenſity.

On the Uſes of Claſſical Learning. By G. GREGORY, *D. D. Domeſtic Chaplain to the Biſhop of Landaff.*

THESE uſes are repreſented to be, a more accurate knowledge of grammar and orthography, of the ſtructure of language, and of etymology, together with the innocent and elegant amuſement they afford, and the acquaintance they give with ancient manners and ſentiments. They improve the heart by excellent maxims of morality, and cultivate the taſte by admirable ſpecimens of beauty in compoſition.

A Diſſertation upon the ancient carved Stone Monuments in Scotland, with a particular Account of one in Dumfriesſhire. By ROBERT RIDDLE, *of Glenriddle, Eſq. F. A. S.*

IN this very ſhort paper ſome of the hieroglyphical monuments of Scotland are enumerated, and a deſcription and figure is given of one ſituated on the banks of the Nith, near the village of Thornhill.

Obſervations on Alphabetical Characters; and particularly on the Engliſh Alphabet: with an Attempt to ſhew its Inſufficiency to expreſs, with due Preciſion, the Variety of Sounds, which enrich the Language. By *Mr.* SAMUEL HARVEY.

THE firſt ſection of this paper contains many remarks and quotations to ſhew the importance of accuracy in the conſtruction of the elemental characters which compoſe alphabets. The ſecond ſection is allotted to a particular examination of the Engliſh alphabet, letter by letter, of which we find it impoſſible to give an abridgment. The numerous defects of our alphabet, and anomalies of our pronunciation have been noted by many authors; and their correction is rather a matter of ingenious ſpeculation than of probable effect.

On the Action of Metallic Oxydes and Earths upon Oils, in low Degrees of Heat. By *Mr.* PETER HENRY.

THE high colour of many of the expreſſed and fatty oils, rendering them unfit for ſeveral uſes in the arts, the writer of this paper inſtituted the experiments of which he gives an account, for the purpoſe of diſcovering a mode of depriving them of their colouring particles. The firſt ſeries conſiſts of trials made by digeſting white arſenic with various oils. Some of them were brightened and cleared by it, but the colour of few was mended. As they had evidently diſſolved much of the arſenic, an attempt was made to precipitate it by the mineral acids, in hopes that the colouring matter might be thrown down along with it; but with no good effect. Some were left as clear as before, but others were much blackened by the acid. Litharge digeſted with the oils had, on the whole, leſs effect than arſenic. Red and white lead, and oxyde of copper, produced no advantage. The earths were then tried; and the earth of alum and clay had a conſiderable effect in depriving oils of their gluten or mucilage. Calcareous earths did no ſervice. None of the earths were in the ſmalleſt degree diſſolved by the oils.

Account of an ancient Mode of Sepulture in Scotland. *By Mr.* ALEXANDER COPLAND.

THE county of Galloway contains a great number of cairns and other cemeteries, which, on being opened, exhibit marks of the action of fire, rendering it probable that the practice of burning the dead was continued longer in this diſtrict than in other parts of the iſland. But one cemetery or burying ground examined by Mr. Copland ſeemed to denote a mixture of burning and inhuming. It was a large encloſure of an oblong form, fenced by a mound of ſtones, and divided within into ſpaces by flat ſtones placed perpendicularly. Beneath ſome ſtones near the entrance were diſcovered three long pieces of iron, which, when ſet up, could be faſtened by an iron pin. This inſtrument Mr. Copland calls a *comburator*; which when uſed, was ſet up on a triangular pavement found beneath the ſurface not far from the middle of the encloſure. The corpſe is ſuppoſed to have been ſuſpended from the comburator by iron chains and hoops, of which a number were found near a ſimilar cemetery not far from the Nith, and are in the poſſeſſion of Mr. Riddell. By this contrivance the body might be conſumed by the ſmalleſt quantity of fuel poſſible. The remains were then depoſited in the niches or ſpaces round the encloſure.

Meteorological Obſervations made on different Parts of the Weſtern Coaſts of Great Britain: arranged by T. GARNETT, *M. D.*

THE firſt of theſe are by Mr. Copland of Dumfries. The following tables contain the principal reſults of ſeveral.

	Quantity of Rain.		Barometer.		Fahren. Thermom. at 10 Forenoon.	
Months.	1792. Inches.	Medium of 15 preced. years. Inches.	1792. Inches.	Medium of 5 preced. years. Inches.	1792. Degrees.	Medium of 5 preced. years. Degrees.
January	3.1801	3.0892	29.528	29.4792	35.956	35.819
February	2.8214	2.8386	29.792	29.6384	41.896	40.5754
March	4.2242	2.0269	29.475	29.7182	44.290	43.540
April	4.196	1.8717	29.739	29.6842	52.800	49.106
May	4.494	2.4397	29.786	29.7921	66.562	58.1452
June	2.606	2.9986	29.702	29.8397	60.439	63.393
July	4.442	3.1769	29.702	29.8282	65.226	66.5798
Auguſt	4.132	31.370	29.797	29.861	66.519	65.2929
September	5.342	4.2837	29.562	29.824	56.133	58.4044
October	4.659	4.1090	29.702	29.6776	49.903	50.1834
November	2.617	3.2107	29.82	29.5823	46.70	40.8916
December	4.797	3.0318	29.579	29.552	39.613	37.593
Total.	47.5130	36.2138			51.3364	50.7960

Total quantity of rain in each year.

		Inches.			Inches.			Inches.
1777	—	34·749	1783	—	33·994	1788	—	26.423
1778	—	42·354	1784	—	27.401	1789	—	48.093
1779	—	41·135	1785	—	30.673	1790	—	39·354
1780	—	40.033	1786	—	32.008	1791	—	39·281
1781	—	29·988	1787	—	38.657	1792	—	47·513
1782	—	40.918						

Taking the north and eaſterly winds in oppoſition to the ſouth and weſterly in this year, 1792, compared with the medium of the eight preceding years, they will ſtand as follows:—

		Medium for years.			Medium.
North	35½	36.25	South	95	73·75
North Eaſt	19	15.06	South Weſt	47	52.12
Eaſt	71½	66.06	Weſt	48	77·69
South Eaſt	23	19.81	North Weſt	27	24.25
Total	149	137.18	Total of S. W. Winds	217 149	227.81

Mr. Copland's tables are accompanied with many meteorological remarks, of which we ſhall tranſcribe one from his laſt letter in January, 1793, which he himſelf ſeems to think the moſt worthy of notice.

" There is one, viz. that the barometer is a moſt certain indication of heat and cold, however imperfect it may be with reſpect to wet or dry weather, which I believe is my own.

" Through the whole of the winter preceding the preſent, I was attentive to the changes and alterations of the weather, and found that not one from cold to moderate weather, and vice verſa took place without its being ſufficiently pre-indicated by a conſpicuous riſe or fall of the barometer; and I believe no winter was more completely varied either in temperature or falls. There was an inſtance of a free thaw with a northerly wind, and a hard froſt with a ſouth-weſt one, for near twenty-four hours each, which could only be accounted for from the firſt being preceded by a high barometer, and the latter by a low one.

" I am now convinced that the altitude of the barometer, as it recedes from the medium of the month, muſt be followed by certain conſequences, which can be reduced to a matter of calculation, and depended on perhaps with more than moral certainty.

" Every remarkable elevation of the barometer, where it is of any duration, is followed by very warm or dry weather, and moderate as to wind, or by all of them; but heat ſeems to have moſt influence and connection; and when it is deficient, the continuance of the other two will be the longer and more remarkable; therefore the calculation muſt be in a compound ratio of the exceſs and deficiency of the heat, and of the dryneſs of the weather in compariſon of the medium of the ſeaſon; and with regard to the want of ſtrong wind, it appears to be intimately connected with the laſt, as they ſhew that no precipitation is going on in any of the neighbouring regions."

The next communication is from Mr. Gough of Kendal; the whole of which we ſhall copy.

Meteorological

Meteorological Remarks in Weſtmorland. *By Mr.* J. Gough, *of Kendal.*[*]

EXPLANATION of the TABLE.

"The firſt column contains the year and month, the ſecond the mean of the barometer at Kendal, the third and fourth the mean of the thermometer, and height of the rain at the ſame place: the fifth the rain at Waith-Sutton, the ſixth that on Benſon-Knot. The ſeventh expreſſeth the ratio of the rain on the Benſon-Knot to that at Kendal, the latter being denoted by unity. This column is added becauſe it was not always convenient to examine the upper gage on the laſt day of the month."

Month.	Mean of Barometer.	Mean of Thermometer.	Rain at Kendal.	Rain at W. Sutton.	Rain at Benſon-knot.	Ratio.
1787.						
June	29,87	—	3,6422			
July	29,78	59,00	5,5549			
Aug.	29,94	58,70	5,4598			
Sept.	29,94	52,20	2,2260			
Oct.	29,63	45,60	8,8750			
Nov.	29,75	37,30	4,5311			
Dec.	29,64	36,20	4,8973			
1788.						
Jan.	29,96	37,10	5,8230			
Feb.	29,48	36.70	3,2115			
March	29,58	36,10	3,1640			
April	29,94	45,74	4,1676			
May	29,98	52,30	1,2919			
June	29.93	56,78	2,5407			
July	29,81	56,50	7,7361			
Aug.	29,838	55,90	3,2919			
Sept.	29,745	52,78	5,6970			
Oct.	30,078	44,60	2,3479			
Nov.	29,977	40,40	3,4286			
Dec.	29,927	30,00	1,0093			
1789.						
Jan.	29.581	32,90	6,9036	5,32		
Feb.	29,498	36,93	9,2058	6,77		
March	29,684	33.90	1,1532	0,53		
April	29,640	42,74	4,5294	3.42		
May	29,780	52,90	5,5618	3,84		
June	29,768	56,30	4,2358	3,86		
July	29.750	58,70	5,2164	6,71		
Aug.	29,996	60,90	1,4856	1,32		
Sept.	29.757	52,70	5,8674	4,64		
Oct.	29,578	45,80	6,4230	6,90		
Nov.	29.610	38,60	6,2496	5,40		
Dec.	29.63	41,50	13,9380	9.25		

Month.	Mean of Barometer.	Mean of Thermometer.	Rain at Kendal.	Rain at Waith-Sutton.	Rain at Benſon-knot.	Ratio.
1790.						
Jan.	29,915	37,90	6,8424	4,99	—	—
Feb.	30.074	41.60	3,6744	2,04	1,32933	,343
March	30,187	40,43	1,5240	1,05	,8843	,580
April	29,864	41.30	2,2320	1,42	3,0192	1,603
May	29,87	52,50	2.4612	1,92	2,3173	,942
June	29.91	56,70	3,9786	6,10		
July	29,73	55,95	7,6848	7,41		
Aug.	29,82	56.50	6,3450	5,69		
Sept.	29,89	50,70	6,7056	7,50		
Oct.	29,81	47,40	4,8636	4,30		
Nov.	29,75	38,90	5,0142	4,75		
Dec.	29,72	35,80	9.8154	7,10	1,9264	,196
1791.						
Jan.	29,325	37,90	8,0316	6,85	1,4871	,213
Feb.	29,820	37,10	6,2118	4,34	1,8098	,247
March	30,050	41,08	3,4140	2,88	,9428	,276
April	29 700	46,20	4,5852	4,67	2,6520	,545
May	29,936	49,57	4,2006	4,06	1,5282	,363
June	29,890	55,70	3,2562	1,62	1,4668	,440
July	29,740	58,10	6,1944	5,43	3,8664	,616
Aug.	29,960	57,50	4,8342	4,98		
Sept.	30,040	53,80	3,0420	2,27		
Oct.	29,600	45,80	5,1720	4,19		
Nov.	29,55	40,80	6,5822	4,40		
Dec.	29,49	31,56	7,8372	4,48		
1792.						
Jan.	29,59	33,80	3,7614	3,13		
Feb.	29.84	38,95	5,3622	3,97		
March	29,60	40,00	6,4854	4.37		
April	29,789	46,88	10,0295	7,44		
May	29,865	49,50	6,3036	5,77		
June	29,855	55,00	3,6486	2,32		
July	29.792	58.86	5.7102	7.19		

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[*] Communicated by Mr. Gough in a letter to Dr. Garnett.

REMARKS.

" This is a correct table of the abſtract of my obſervations, on the meteorology of Weſtmorland. The mean height of the barometer at Kendal, collected from the obſervations of five years, beginning July 1787, is 29,7845. The mean of the thermometer, at the ſame place, for five years, beginning July 1787, is 46,08. The annual mean height of the rain, for an equal period, is 61,2235. It will be neceſſary after what has been ſtated above, to ſay ſomething relative to the ſituation of the town.

" It is placed on the weſt ſide of a long valley opening to the S. W. Benſon-Knot, on which a rain gage has occaſionally been placed, ſtands about two miles N. E. of the town, and is the higheſt ground in the neighbourhood; its elevation above the river appears to be nearly 320 yards, by barometrical meaſurement. The height of the town, above the ocean, is 66 yards, calculated from the ſame principles, that is, from the ſame barometrical mean ſpecified above; but, in all probability, does not exceed 40 yards; conſequently Benſon-Knot, on the latter ſuppoſition, riſes 360 yards above the ſame level. The diſtance of the neareſt ſea does not exceed 30 miles, from which an eſtuary called Kent ſands, advances to within five miles of Kendal. It is manifeſt from the laſt column in the table, that the comparative quantity of rain on the hill, is leſs in winter than in ſummer. The fact is ſupported by the experiments of two ſucceſſive years, both of which were favourable to the enquiry, becauſe little ſnow fell in either ſeaſon; but though it would be raſhneſs to maintain that the law is fairly eſtabliſhed, yet the following circumſtances argue ſtrongly for the truth of it. The mean height of the thermometer in wet weather, in winter, is nearly 40°. that is 8°. above the freezing point. Now if we allow that the temperature diminiſhes half a degree with every 200 feet of elevation, with Mr. Kirwan, the mean height of the point of congelation will be 1066 yards, from which if we ſubtract 320, the height of the hill, there remains 746 for the length of the column of air, that affords the rain collected by the upper gage in winter. On the other hand, the mean height of the thermometer in wet weather, in ſummer, is about 54°. conſequently, the length of the column that ſupplies rain to the upper gage in the warmer part of the year, is 2613 yards, and the mean height of the point of congelation is 2933: but the ratio of 1066 to 746, is greater than that of 2933 to 2613; and as no rain can be formed above the point of congelation, it follows from induction, that when the ratio of the columns that ſupply the upper and lower gages is leaſt, the quantities collected by them will approach the neareſt to equality, and the contrary.

" This inclination agrees well enough with the remarks in the table, when a proper allowance is made for ſhowers which fall very partially in mountainous countries. In April 1790, a heavy ſhower fell on the upper gage, while the water received by that in the town was very trifling. This accounts for the ſtrange deviation from the general rule obſervable in the notes for that month.

" The annual mean height of the rain at Waith-Sutton, for three years, beginning January 1789, is 54,13; the ratio of which is to that of Kendal, for the ſame time, as 0,82 to 1. If the ratios of the three winter months, December, January, and February, and of the three ſummer months, June, July, and Auguſt be taken, the former will be as 0,71 to 1; and the latter as 1,001 to 1, a phænomenon that cannot be explained clearly from any thing we know at preſent, yet the fact is certain, becauſe the ratios are determined from long periods. Is it that the air is more powerfully ſolicited in winter to depoſit its water, by approaching the hills, than it is in ſummer? The idea is a mere conjecture, but the comparative ſituations of the two places does not afford a better. Waith-Sutton lies about ſeven miles S. W. of Kendal, and about three miles from the eſtuary before mentioned; its height above the high-water mark of the tide, does not exceed five or ſix yards: the country about it being flatter and more open, than it is a few miles farther north.

" Tarlton-Knot, about a mile and a half ſouth eaſt of it, is the only hill of note in the neighbourhood; it is a high barren rock of lime-ſtone.

" The general concluſions contained in theſe remarks, are eſtabliſhed on the means of the different obſervations, which is the true way of reaſoning on the ſubject."

FELLFOOT RAIN GAGE.*

1788.	In.Pts.	1789.	In.Pts.	1790.	In.Pts.	1791.	In.Pts.
January	5,80	-	5,71	January	5,61	-	6,83
February	4,06	-	8,59	February	2,56	-	5,13
March	4,34	-	3,38	March	1,38	-	3,21
April	3,95	-	4,11	April	0,93	-	4,76
May	1,25	-	6,25	May	3,78	-	3,73
June	2,96	-	4,93	June	4,50	-	1,29
July	6,77	-	5,92	July	5,75		
Auguſt	3,24	-	1,38	Auguſt	7,43		
September	4,44	-	4,18	September	6,82		
October	2,61	-	7,77	October	5,37		
November	2,15	-	5,18	November	5,76		
December	0,49	-	9,12	December	8,59		
Total	42,06	Total	66,52	Total	58,48	Total	

Depth of rain which fell at Salford, communicated by Mr. Geo. Walker.

1790.	In.	Lines.
January	2	3
February	1	3
March	1	0
April	2	3
May	3	3
June	5	6
July	5	9
Auguſt	4	6
September	3	9
October	2	9
November	3	3
December	7	3
	42¾ In.	

I have not received the account for 1791.

J. G.

1792.	Inches.	Rain or Snow.
January	2	19 Days.
February	2	16
March	2,75	24
April	2,5	16
May	8	26
June	3	24
July	3,75	24
Auguſt	6,25	18
September	9	26
October	4	17
November	2	12
December	9,5	26
	Inches 54¾	248

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* Communicated to Dr. Percival by Lord George Cavendiſh. Fellfoot lies at the ſouth end of Winander-meer.

Barometer.

Higheſt	Feb. 17th.	30,25
Loweſt	Sep. 21ſt.	28,8

Farenheit's Thermometer, North aſpect.

Jan.	19,	8 Morning,	19°.	wind	N. E.
April	13,	4 P. M.	68		Eaſt.

April 10th, in the ſunſhine 104°.

Meteorological Obſervations at Lancaſter, with Remarks on the ſame. By Dr. CAMPBELL, *of Lancaſter.*

Perpendicular height of the rain that has fallen at Lancaſter, during the laſt ſeven years, in inches and lines; diſtinguiſhing each month and year.

	1784		1785		1786		1787		1788		1789		1790		Total in the ſame months of the foregoing years.	
	In	Li	I	L	I	L	I	L	I	L	I	L	I	L		
January	2	8¼	2	6	2	6	1	7½	2	10	4	5	5	11	22	5¾
February	2	3¾	0	6⅓	1	1	5	0	2	1	4	11	1	2¼	17	1¼
March	2	7½	0	1	0	11	3	7⅓	1	10	0	8⅓	0	8	10	4⅔
April	3	0	1	8	0	4½	1	3½	2	7½	4	3¾	1	3½	14	6¾
May	3	0	1	6	1	8	1	4¼	1	1	4	1½	2	1	14	9¾
June	5	9	1	0½	1	10	3	6	2	0⅓	5	2½	4	0	23	1¼
July	3	0	2	1½	2	9½	7	0	6	5	5	7¾	7	6	34	5¾
Auguſt	5	0	10	4	5	0	7	0	2	0¾	0	5½	3	10⅓	33	8½
Sept.	2	7	5	6	7	11	2	0	3	7¼	4	1¾	5	5	31	2
October	0	8	5	9	1	6	9	9	2	1½	6	6	2	9	29	0½
Nov.	3	0	4	6	3	0	4	5½	1	9¾	4	1	4	6⅓	25	4½
Dec.	1	6	1	2	3	8	4	5	0	10⅛	6	6	7	4	25	5⅓
Total in each year	35	1½	36	8⅓	32	3	51	01-12	29	45-12	51	01-12	46	61-12	Averages nearly	40.3.4-12

During a thunder ſtorm in Aug. 1785, there fell at Lancaſter near ſix inches perpendicular of rain one afternoon.

Upon an average of ſeven years the winds have blown in the following directions:

	N.	N. E.	N. W.	S.	S. E.	S. W.	E.	W.	
Days.	30	67	26	51	35	92	17	47	Mean year.

Taking the north and eaſt winds, in oppoſition to the ſouth and weſt, they ſtand as follows:

North	——	30	South	——	51
N. E.	——	67	S. W.	——	92
S. E.	——	35	N. W.	——	26
Eaſt	——	17	Weſt	——	47
	Days	149		Days	216

Mean Heat at LANCASTER, During the following Years.

	1784		1785		1786		1787		1788		1789		1790	
	2 P.M	10 P.M	2 P.M	10 P.M	2 P.M	10 P.M	2 P.M	10 P.M	2 P.M	10 P.M	2 P.M	10 P.M	2 P.M	10 P.M
Jan.	34.	30.	41.19	37.18	38.22	36.18	41.12	39.13	41.8	38.10	36.14	34.17	42.	40.
Feb.	37.19	33.7	36.13	32.7	40.17	37.	48.3	40.16	43.19	35.5	42.4	40.	46.17	43.
March	42.	34.10	38.20	32.18	40.29	34.14	47.9	42.11	41.14	37.	96.18	34.15	46.	41.13
April	48.	40.17	52.16	43.12	54.5	44.4	47.9	46.2	52.	46.	48.16	42.18	47.15	40.6
May	60.19	50.25	60.	50.	55.9	48.6	60.3	50.6	63.	51.16	59.5	52.	59.	50.20
June	62.	53.6	68.8	56.19	68.4	56.23	64.9	52.10	65.	55.7	63.	54.5	62.15	54.
July	64.18	55.24	66.9	57.15	63.3	56.1	66.	55.21	59.	56.	67.	55.	63.6	54.21
Aug.	62.18	53.22	60.	53.19	63.11	56.23	61.	55.	62.12	55.	68.7	60.	65.12	56.14
Sept.	64.17	55.21	60.8	53.7	56.4	51.4	60.7	52.	59.10	55.	59.	54.23	58.10	51.
Oct.	51.15	44.	49.11	44.18	47.	44	55.22	47.15	55.6	47.16	50.	46.	56.9	49.
Nov.	45.	40.21	45.17	41.20	37.	37.26	46.20	38.	46.	42.	44.	38.14	46.6	41.
Dec.	35.	31.	39.1	36.15	38.11	36.19	42.22	38.8	35.8	30.19	46.	43.	40.	38.
Mean Heat	50.8	43.7	51.6	44.11	50.6	44.1	53.	46.5	51.10	45.9	51.7	45.5	52.9	46.5

Mean Heat of the ſame Months in the foregoing years.

	2 P.M	10 P.M
Jan.	39.1	36.4
Feb.	41.3	37.2
March	41.6	36.4
April	50.	43.2
May	59.3	50.3
June	64.5	54.4
July	64.1	56.
Aug.	63.2	55.5
Sept.	59.4	53.1
Oct.	52.1	46.2
Nov.	45.5	39.5
Dec.	39.2	36.2
Mean Heat	51.8	45.6

Mean Heat of Seven Years, Noon and Night. 48.7

Higheſt degree	-	82
Loweſt	- -	18

Philoſophical Tranſactions of the Royal Society of London, for the Year 1793. *Part* I.

I. *An Account of two Rainbows, ſeen at the ſame Time, at Alverſtoke, Hants, July* 9, 1792. *By the Rev. Mr.* STURGES.

THE two rainbows were ſeen on the ſea coaſt in a thunder ſhower, which came up in the ſouth-eaſt, between ſeven and eight o'clock in the evening. (See Plate XVIII. Fig. 2.) AB. AC. repreſent the two primary bows, meeting each other at A, in the ſouth part of the horizon: DE. DF. the two ſecondary bows, the latter very faint, but diſcernible. The primaries were very vivid for a conſiderable time, and at times nearly equally ſo: but AB was moſt permanent, and near ſun ſetting, when the other had vaniſhed, became almoſt a ſemicircle. The ſea was as ſmooth as glaſs.

For the ſolution of this phænomenon, AB is conſidered as the true bow, and AC as produced by the reflection of the ſun from the ſea. The image, reflected from the water, having its rays iſſuing from a point lower than the real ſun, and in a line coming from beneath the horizon, would form a bow higher than the true one: and the ſhores, intercepting the ſun's rays from the ſurface of the water, cauſed the bow AC to diſappear before the other.

II. *Deſcription of the double-horned Rhinoceros of Sumatra.* By *Mr.* WILLIAM BELL, *Surgeon.*

THE animal here deſcribed, was ſhot about ten miles from Fort Marlborough. The writer drew up the following deſcription the next day, when it was not at all putrid.

" It was a male, the height at the ſhoulder was four feet four inches; at the ſacrum nearly the ſame; from the tip of the noſe to the end of the tail, eight feet five inches. From the appearance of its teeth and bones it was but young, and probably not near its full ſize.

" The ſhape of the animal was much like that of the hog. The general colour was a browniſh aſh; under the belly, between the legs and folds of the ſkin, a dirty fleſh colour.

" The head much reſembled that of the ſingle horned rhinoceros. The eyes were ſmall, of a brown colour; the *membrana nictitans* thick and ſtrong. The ſkin ſurrounding the eyes was wrinkled. The noſtrils were wide. The upper lip was pointed, and hanging over the under.

" There were ſix *molares*, or grinders, on each ſide of the upper and lower jaw, becoming gradually larger backward, particularly in the upper. Two teeth in the front of each jaw.

" The tongue was quite ſmooth.

" The ears were ſmall and pointed, lined and edged with ſhort black hair, and ſituated like thoſe of the ſingle horned rhinoceros.

" The horns were black, the larger was placed immediately above the noſe, pointing upwards, and was bent a little back; it was about nine inches long. The ſmall horn was four inches long, of a pyramidal ſhape, flattened a little, and placed above the eyes, rather a little more forward, ſtanding in a line with the larger horn, immediately above it. They were both firmly attached to the ſkull, nor was there any appearance of joint, or muſcles to move them.

" The neck was thick and ſhort, the ſkin on the under ſide thrown into folds, and theſe folds again wrinkled.

" The body was bulky and round, and from the ſhoulder ran a line, or fold, as in the ſingle horned rhinoceros, though it was but faintly marked. There were ſeveral other folds and wrinkles on the body and legs; and the whole gave rather the appearance of ſoftneſs.

" The legs were thick, ſhort, and remarkably ſtrong; the feet armed with three diſtinct hoofs, of a blackiſh colour, which ſurrounded half the foot, one in front, the others on each ſide. The ſoles of the feet were convex, of a light colour, and the cuticle on them not thicker than that on the foot of a man who is uſed to walking.

" The teſticles hardly appeared externally.

" The penis was bent backward, and opened about eighteen inches below the anus. At its origin it was as thick as a man's leg, and about two feet and a half long; the bend in it occaſions the urine to be diſcharged backwards. The glans is very ſingular: the opening of the urethra is like the mouth of a cup with its brim bending over a little, and is about three quarters of an inch in diameter; the glans here is about half an inch in diameter, and continues that thickneſs for an inch and a half; it is then inſerted into another cup like the firſt, but three times as large. The glans afterwards gradually becomes thicker, and at about nine inches from the opening of the urethra are placed two bodies on the upper part of the glans, very like the nipples of a milch cow, and as large; theſe become turgid when the penis is erected. The whole of this is contained in the prepuce, and may be conſidered as glans.

" From the os pubis ariſes a ſtrong muſcle, which ſoon becomes tendinous. This tendon is continued along the back, or upper part, of the penis; it is flattened, is about the ſize of a man's little finger, and is inſerted into the upper part of the glans, near the end. The uſe of this muſcle is to ſtraiten the penis.

" On the under ſide of the penis there are two muſcles, antagoniſts to the above; they ariſe from the os iſchium fleſhy, run along the lower ſide of the penis, on each ſide of the corpus ſpongioſum, and are inſerted fleſhy into the lower ſide of the glans. The action of theſe muſcles will draw in the penis, and bend it.

" The male has two nipples, like the female, ſituated between the hind legs, they are about half an inch in length, of a pyramidal form, rounded at the end.

" The whole ſkin of the animal is rough, and covered very thinly with ſhort black hair. The ſkin was not more than one third of an inch in thickneſs, at the ſtrongeſt part; under the belly it was hardly a quarter of an inch; any part of it might be cut through with eaſe, by a common diſſecting knife.

" The animal had not that appearance of armour which is obſerved in the ſingle horned rhinoceros.

" Since I diſſected the male, I have had an opportunity of examining a female, which was more of a lead colour; it was younger than the male, and had not ſo many folds or wrinkles in its ſkin, of courſe it had ſtill leſs the appearance of armour.

" The only external mark which diſtinguiſhes it from the male is the vagina, which is cloſe to the anus; whereas, in the male, the opening for the penis is eighteen inches below the anus."

III. *Deſcription of a Species of Chætodon, called, by the Malays, Ecan bonna. By Mr.* William Bell.

" THE fiſh called *Ecan bonna*, by the Malays, is broad, flat, and of a lead colour; the belly is flat, white, and in places tinged with green. The eyes are a bright yellow. The body is covered with ſmall ſemicircular ſcales.

" Its length is generally about eighteen inches; its breadth thirteen, and, at the thickeſt part, it is nearly three inches thick.

" It is frequently caught at Bencoolen, and ſeveral other parts on the weſt coaſts of Sumatra, and is ſaid to grow to a much larger ſize. Its fleſh is white, firm, and well flavoured, and it is conſidered as a good fiſh for the table.

" It has ſix fins: two pectoral, two ventral, one dorſal, and one anal fin. The tail is broad, and of a triangular form.

" The pectoral fins are ſmall, blunted at their ends, and placed a little behind the gills.

" The ventral fins are placed on the ſternum, and are longer, and more pointed.

" The dorſal fin ariſes at the beginning of the ſpinous proceſſes of the back, and is continued down nearly to the tail.

" The anal fin ariſes a little below the anus, and is alſo continued on almoſt to the tail. It is ſtrong and broad, like the dorſal, and projects a little farther backward than it.

" The mouth is ſmall, and each jaw contains five rows of ſmall teeth, about the thickneſs of hog's briſtles, and of equal thickneſs throughout their length. The grinding, or cutting ſurfaces of the front, ſecond, and third rows, in both jaws, are divided into three points. The two inner rows are pointed, and bent a little backward.

" The ſtomach was empty, ſo that I had not an opportunity of aſcertaining its food. The inteſtinal canal was long, like that of fiſh which feed on vegetables; and the œſophagus was thick ſet with pyramidal bodies, like the œſophagus of the turtle.

" The ſkeleton is very ſingular, many of the bones having tumours, which, in the firſt fiſh I ſaw, I ſuppoſed to be exoſtoſes ariſing from diſeaſe; but on diſſecting a ſecond, found the correſponding bones had exactly the ſame tumours, and the fiſhermen informed me they were always found in this fiſh; I therefore conclude them to be natural to it.

" In Mr. Hunter's collection are two or three of theſe bones, but I never knew what fiſh they belonged to; they were ſuppoſed to be from the back of ſome of the large rays.

" What advantage can ariſe from theſe large tumours is difficult to ſay. Thoſe on the ſpines of the vertebræ ſeem to anſwer no evident purpoſe, nor thoſe at the origin of the dorſal, and anal fins. The particular form of the ſternum, to which the ventral fins are joined, ſeems to be intended to give greater ſurface for the attachment of the muſcles, and to increaſe their action.

" Theſe tumours are ſpongy, and ſo ſoft as to be eaſily cut with a knife; they were filled with oil.

" The air-bladder is very large, for the ſize of the fiſh, probably, to counteract the weight of the bony matter in the ſkeleton.

" It is generally caught near the ſhore, where there are ſea-weeds, and the Malays ſay it is a dull ſwimmer."

Plate XVIII. Fig. 3. Repreſents the ſkeleton of the ſame.

IV. *Account of ſome Diſcoveries made by Mr.* Galvani, *of Bologna; with Experiments and Obſervations on them. In two Letters from Mr. Alexander Volta, F. R. S. Profeſſor of Natural Philoſophy in the Univerſity of Pavia, to Mr. Tiberius Cavallo, F. R. S.*

MR. GALVANI, a profeſſor at Bologna, publiſhed in 1791, in Latin, a Commentary on the powers of Electricity in Muſcular Motion. The very curious diſcoveries traced out in this work excited much attention in Italy; and in the preſent letters (written in French) Seignir Volta gives a ſketch of them, together with the progreſs he himſelf has made in purſuing the ſame track. We ſhall give as conciſe a view as poſſible of the ſubſtance of theſe letters.

Dr. Galvani, having prepared a frog ſo that its hind-legs adhered to a part of the ſpine cut off from the reſt of the body, only by the crural nerves which were laid bare, obſerved that vigorous motions in the legs, with ſtrong contractions of all the muſcles, were excited; whenever this portion of the animal being placed at a conſiderable diſtance from the grand conductor of an electrical machine, ſparks were drawn from the conductor, not by the animal, but by any other body, and in any direction. The requiſite circumſtances were, that this animal portion ſhould be in contact with, or near, ſome metal or other good conductor ſufficiently extenſive, or better ſtill, between two ſuch conductors, one turned towards the extremity of the legs, the other towards the ſpine. It was alſo very advantageous, that one of the two conductors, which the author diſtinguiſhes by the name of *nervous conductor* and *muſcular conductor*, ſhould have a free communication with the floor.

Mr. Galvani was aſtoniſhed at this phænomenon, more, Mr. Volta thinks, than he needed to have been; ſince the great exciting power, not only of ſparks, but of a current of electric fluid paſſing rapidly over an animal body, was a thing well known; and it was evident from his figures, that his frog was in effect expoſed to ſuch a current, or reflux of the electric fluid in the conductors on each ſide of it, to which his body, by the narrow canal of the nerves, ſerved as a medium of communication. The wonder was, that ſuch violent movements ſhould be excited by an electric current not ſenſible to the moſt delicate electrometers. Mr. Volta applied himſelf with attention to determine what was the ſmalleſt electric force requiſite to produce theſe effects, as well in an intire frog, as in a portion prepared in the above manner. For this purpoſe he expoſed it, inſulated, to the direct diſcharges of a conductor, or of a Leyden phial, thus making the electric ſtream paſs through its body. He found that for a living middle-ſized frog, a power of electricity from the conductor which would raiſe Henly's electrometer 5 or 6 degrees, was ſufficient; and a much weaker from the Leyden phial, viz. one which gave no ſpark, and was able only to ſeparate about a line the little pendulums of Cavallo's electrometer. But in a frog diſſected in Galvani's manner, convulſions were excited by an electricity 40 or 50 times weaker, a charge of the bottle abſolutely inſenſible to Cavallo's or Bennet's electrometer, and only ſenſible by aid of his own *condenſer*. Thus a portion of a frog prepared by baring its nerves may furniſh a new electrometer, which may be termed an *animal* one.

If theſe experiments prevent ſurprize at thoſe deſcribed in the firſt and ſecond parts of Mr. Galvani's work, we cannot, however, but be aſtoniſhed at thoſe in his third part, by which he produces the ſame convulſions and violent muſcular motions, without having recourſe to any artificial electricity whatever, by the ſole application of a *conducting bow* of any kind, one end of which ſhall touch the muſcles, the other, the nerves or ſpine of the prepared animal. This bow may be either entirely metallic, or part metallic, part of any other body of the conducting claſs. Nothing but the interpoſition of non-conductors can prevent the effect. Bad conductors, however, do not ſerve ſo well, and only while the vital powers of the frog remain vigorous; afterwards, only good conductors ſerve the purpoſe, and finally, only the beſt of all. Further, a great advantage was found in arming the nerve with lead or tin foil. Mr. Galvani extended his experiments not only to other cold-blooded animals, but to warm quadrupeds and birds, and obtained the ſame reſults by the ſame preparations of baring the nerve going to a limb, arming it with metal, and eſtabliſhing a conducting bow. He thus diſcovered and clearly demonſtrated the exiſtence of a real *animal electricity*, and proved that the electric fluid inceſſantly tends to paſs from the nerves to the muſcles or *vice verſa* of every living body or part of a body, and that to this transfuſion muſcular motions are owing. The explanation Mr. Galvani gives of this fact from a reſemblance to the diſcharge of the Leyden phial, ſeems inconteſtible;

yet a great number of new experiments have ſhewn Mr. Volta that there are certain reſtrictions to be made both with reſpect to the fact, and the author's deductions.

Mr. Galvani, according to his ideas, ſuppoſes that there is naturally an exceſs of electric fluid in the nerve or interior of the muſcle, and a correſpondent defect in the exterior, or *vice verſa*; and conſequently, that one end of the bow ſhould communicate with the nerve, the other with the external face of the muſcle. But Mr. Volta has found from experiment, that this double contact is not always neceſſary, and that the convulſions may be excited by metallic contacts either on two parts of the nerve alone, or on two muſcles, or on different points of the ſame muſcle. This method, indeed, does not ſucceed nearly ſo well as the other, and it is neceſſary to employ two different metals. But in this caſe, the equilibrium of the electric fluid is rather diſturbed than re-eſtabliſhed; it muſt therefore proceed from a different law of electricity; and this, Mr. Volta thinks rather to be a law of common, than of animal, electricity. He therefore conceives the greater part of the phænomena related by Galvani, to be owing to the action of a very weak artificial electricity, rather than a real ſpontaneous animal one; and the diſcovery of this new law induced him at firſt to doubt of the whole theory of animal electricity. But on a careful re-examination of the phænomena, and repetition of the experiments, he became convinced, that the theory ſupported itſelf by demonſtrative proofs, though much more limited than had been ſuppoſed. It is mortifying that theſe reſtrictions oblige us to renounce what appeared a clear explanation of the cauſe of muſcular motion; for his experiments ſhewed, that the electric fluid does not act immediately on the muſcles, but only excites the nerves, which in their turn excite the muſcles, after a manner of which we are ſtill as ignorant as before.

Mr. Volta next proceeds to his own experiments, premiſing an obſervation reſpecting thoſe of Galvani,---that they are confined to too narrow a circle, all of them conſiſting in eſtabliſhing an electrical communication by means of conductors, between inſulated nerves and muſcles, whereby a transfuſion of electric fluid might take place to or from theſe different organs.

Exper. A. He ſeizes with pincers the iſchiatic nerve a little above its inſertion into the thigh, and applies ſome lines higher a piece of money or other metallic plate to the ſame nerve carefully detached from its adheſions, and held by a thread, or ſupported by ſome bad conductor, as glaſs, wax, or dry wood. Then, applying the belly of a Leyden phial very weakly charged to the pincers, he brings its wire hook in contact with the metallic plate, and makes the diſcharge, which, though not giving the leaſt ſpark, convulſes all the muſcles of the thigh and leg. Yet all this leg, and even a part of the nerve, was without the courſe of the electric fluid.

Exper. B. The ſame motions take place without having recourſe to foreign electricity, by the diſcharge naturally made, when having applied the ſame pincers, or a piece of ſilver, to one part of the nerve, and a piece of lead or tin to another part, a communication is made, either by bringing them into contact, or joining them by a third piece of metal.

Exper. C. The armings or plates of different metals are applied to a whole and entire living frog, even with its ſkin on. For example; a piece of tin foil is glewed on its back or loins, and a piece of ſilver coin is placed under its belly or thighs with a little compreſſion. The coin is then ſlid till it touches the tin foil, or a communication is made by a piece of wire; and inſtantly ſpaſmodic motions are excited in all the muſcles of the belly, thigh, and back, with violent contractions of the legs and ſpine; theſe movements being eſpecially remarkable in the muſcles which touch the metals, or are ſupplied with nerves from the neighbourhood where they are placed. Though this will ſucceed with fiſhes and frogs with their ſkins on, yet it anſwers better if they are ſtripped. It is alſo advantageous to cut off the frog's head and deſtroy its ſpinal marrow, that the motions may not be confounded with thoſe of life.

Exper. D. A lizard, mouſe or chicken is faſtened to a table with large needles, and an inciſion being made on the back to the naked fleſh, the integuments are turned off on each ſide; the ſame is done to the thigh or leg. The metals are then applied, and the communication made as before, when ſtrong contractions are excited in the adjacent muſcles, eſpecially of the thigh or leg. Theſe are more violent, according as the tin foil is applied nearer the iſchatic nerve, and the ſilver to the gluteus or gaſtrocnemius muſcle; and ſtill more, if the nerve itſelf is bared and coated with the tin, if it is ſeparated from all other adheſion except that to the muſcles in which it is implanted, and if the limb with its nerve is ſeparated from the reſt of the body. Similar experiments were tried with larger animals, as rabbits, dogs, lambs, oxen, with ſimilar ſucceſs.

Exper. E. A leg with the thigh, a leg alone, half or a quarter of a leg was cut off from a frog, and on applying tin-foil to one part of it, and ſilver to another, and procuring a communication, convulſive motions were always produced. A ſingle detached muſcle or piece of a muſcle treated in the ſame manner exhibited the ſame appearances.

Exper. F. The ſame experiments were ſucceſsfully repeated on the truncated limb or part of a limb, muſcle or part of a muſcle, of birds and quadrupeds. Thus it appears, that in order to excite the muſcles to action, it is not neceſſary to make a diſcharge of electric fluid between nerve or muſcle, or from the exterior to the interior of the latter by the medium of the nerve, as Galvani ſuppoſes; and that in theſe experiments there is no compariſon to be made with the Leyden phial and its diſcharge.

Exper. G. Having coated with tin and ſilver foil the two thighs of a frog in the correſponding parts, contractions are excited the inſtant the communication is made by the conducting bow. Here alſo is no analogy with the Leyden phial.

Exper. H. If two muſcles, or two parts of the ſame muſcle, have coatings of *the ſame* metal, equal alſo in their temper and poliſh, no motion whatever follows on their communication.

Although the preceding experiments would ſeem to prove as a general fact, that by arming muſcles with different metals contractions may be produced in them as long as any vitality remains, yet this fact is reſtricted, both relatively to the claſſes of animals, and to the different muſcles of the ſame animal.

Exper. I. Tin-foil and ſilver were applied to different parts, exterior and interior, of ſnails, leeches, earth-worms, and others of the claſs of *vermes*, and different caterpillars, but in whatever manner the communication was made, not the leaſt motion enſued.

Exper. L. Diſcharges of the phial, ſtrong enough to excite a moderate ſpark, were ſent through their bodies, inſulated or not, with no more effect.

Exper. M. After cutting off the head of a fly, butterfly, beetle, &c. and ſlitting their corſelet, a piece of tin-foil is introduced deep into the ſlit near the neck, and a little beneath is introduced the edge of a piece of ſilver, as a ſmall coin: when theſe are brought into contact, the legs begin to bend and ſtruggle, and even the trunk to move.

From theſe different effects in different animals, it is Mr. Volta's opinion, that thoſe only which have diſtinct limbs, joints, and muſcles for their motion, are capable of being excited to ſpaſmodic contractions by the ſmall current of electric fluid in theſe proceſſes, whereas thoſe which have no ſuch diſtinctions of parts, and poſſeſs only vermicular motion, have no ſuch ſuſceptibility. With reſpect to the different muſcles of the ſame animal, thoſe only which are under the power of the will, and ſerve for the voluntary motions, are liable to be excited to contraction by theſe methods.

Exper. N. A good piece of muſcular fleſh cut, for example, from the thigh of a lamb killed half an hour or an hour before, almoſt cold, and no longer ſenſible to any mechanical or chymical ſtimulus, will be thrown into ſtrong ſpaſms by the electric fluid, while the heart of the ſame animal, ſtill warm and irritable, undergoes no alteration from the electric ſtimulus, applied with every advantage of coating, &c.

It has been already mentioned, that Mr. Volta was convinced by his experiments, that the electric fluid in theſe caſes is not the immediate cauſe of muſcular contraction, but that it acts only through the medium of the nerves. Thus the ſtrongeſt convulſions are produced, not by tranſmitting the current through the muſcles of the limbs themſelves, but through the nerves which ſupply thoſe muſcles.

Exper. O. If in a frog the tin-foil be applied all the length of the ſpine of the back, and the other metal to ſome other part, the convulſions are general, as well in the belly and back as the legs.

Exper. P. The head of a lizard being cut off, and the muſcles of the back bared by removing the ſkin, a piece of tin-foil was applied to the truncated extremity ſo that it paſſed over to the ſhoulders, and a piece of ſilver was laid on the middle of the ſpine. On ſliding the latter till it touched the tin-foil, the legs were inſtantly put in motion, the tail writhed about, and the whole body bent and turned from ſide to ſide. This experiment will anſwer in mice and ſmall birds, provided the fleſh alſo which covers the principal nerves and ſpinal marrow be removed; but in the larger animals they are ſtill too much concealed by the bones for general contractions to be excited in this manner.

On wiſhing to make ſome experiments on the human body, the tongue occurred to Mr. Volta as an organ of voluntary motion, very ſenſible, and covered with extremely thin teguments, and therefore having all the requiſites for this purpoſe.

Exper. Q. Having covered the point of his tongue and a part of its ſuperior ſurface to the extent of ſome lines, with tin-foil, he applied the convex part of a ſilver ſpoon further on the tongue, and inclined it forwards ſo as to meet the tin. No movement was the reſult, but he was ſenſible of a pretty ſtrong ſour taſte at the tip of his tongue.

Exper. R. Having cut out the tongue near the root of a newly killed lamb, he applied tin-foil to the cut part, and a ſilver ſpoon to one of its ſurfaces. On eſtabliſhing the communication, the tongue was ſeen to tremble briſkly, and its point to riſe, fold back, and turn from ſide to ſide. This experiment was repeated with the ſame ſucceſs on a calves tongue, and upon the tongues of ſeveral ſmall animals, though in the latter it ſometimes failed.

V. *Further*

V. *Further Particulars reſpecting the Obſervatory at Benares, of which an Account, with Plates, is given by Sir Robert Barker, in the LXVIIth Vol. of the Philoſophical Tranſactions. In a Letter to W. Marſden, Eſq. F.R.S. from* John Lloyd Williams, *Eſq. of Benares.*

A. * The large quadrant, (Plate XVIII. Fig. 4.) in Arabic *kootcop-bede*, and in Hindoo, *droop*, the name of the north polar ſtar, is built of ſtone, fixed in mortar, and clamped with iron in a very clumſy manner, the interſtices of the ſtones being in general $\frac{1}{16}$ part of an inch. The ſtile meaſured from north to ſouth, 39 feet 6$\frac{1}{2}$ inches: height of the north end 22 feet 3 inches; of the ſouth end 5 feet 4$\frac{1}{4}$ inches. It conſiſts of two walls 11$\frac{1}{2}$ inches thick, with a flight of 27 ſteps between; on the outer edge of each are fixed two iron rings, diſtant the uppermoſt from the top 18 feet 8 inches, the lower from the bottom 15 feet and $\frac{1}{2}$ an inch, and from each other 5 feet 8$\frac{1}{2}$ inches, both ſides are nearly alike. The rings are $\frac{3}{4}$ of an inch thick, and let into the wall between two ſtones: the object holes, of which $\frac{5}{8}$ths are covered by the projection of the ſtone, are $\frac{5}{16}$ths of an inch in diameter. The radius of one of the quadrants, on which the hour lines are marked, from the outer part of the wall of the ſtile to the inner edge of the arc, is 9 feet and $\frac{3}{4}$ths of an inch, of the other, 9 feet 1 inch. The width of the rim of the quadrants is 5 feet 10$\frac{1}{4}$ inches. The quadrant is divided into 6 gurries, and each gurry into 10 pulls.

On the outer wall of the ſtile, fronting the eaſt, are two iron pins 10 feet 10 inches from the baſe, from which circular lines are drawn, with a parallel line underneath, having the hour or gurry and pull lines marked on it. The wall is plaiſtered, and on other edifices fronting the eaſt are ſimilar lines, whoſe uſe it is ſaid, was to aſcertain the time of day.

B. An equinoctial dial, called *gentu-rage*, is a circular ſtone inclining to the ſouth. The diameter of the ſouth face is 2 feet 2$\frac{3}{4}$ inches, and its perpendicular height is one foot. In the ſouth front of this ſtands a ſmall ſtone pillar, diſtance 3 feet 8 inches, and the time of day is ſhewn by the ſhadow of a line drawn from the center of the dial, to the top of the pillar. On the nadir ſide of the dial, the ſtone is 4 feet 7 inches diameter, and in its center is a ſmall iron ſtile, with a hole in it, perpendicular to its plane, and in the perpendicular line of the chord are two ſmall irons. A line paſſing through the hole in the ſtile, and each end applied to the irons, does by its ſhadow denote the hours.

C. A braſs circle in the plane of the equator, called *cund-brit* or *cranti-brit*, has a moveable index turning on a pivot in the center. The circle is divided into 360 degrees or *unſe*, each degree into $60'$, and again into $6''$, and into $\frac{1}{4}$ths. Its uſe is not known.

D. A double circular wall with a round pillar in the center: the height of the outer wall from 8 feet 1 inch, to 8 feet 3 inches, the inſide diameter 27 feet 6$\frac{1}{2}$ inches; thickneſs of the wall 2 feet. Diameter of the inner wall 18 feet, thickneſs 1 foot 5$\frac{1}{2}$ inches. Diameter of the center pillar 3 feet 7$\frac{1}{2}$ inches. On the top of the outer wall, at the four cardinal points are iron pins with ſmall holes in them, through which to the oppoſite points wires are drawn, by whoſe ſhadow, it is ſaid, the ſun's declination is found. The tops of both walls are graduated.

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* The references are to the plate annexed to Sir Robert Barker's account.

On the ſouth eaſt quarter of the building is a large black ſtone, 6 feet 2 inches diameter, ſtanding on an inclined plane, and fronting the weſt; its uſe is not known, but it is ſaid not to have been compleated.

From the nabob Ali Ibrahim Kaun, we learn, that the whole area is called in Hindoo, *maun-mundel*, the cells and lower part were built at a period, whoſe date is unknown, by Rajah Maunſing, for the pilgrims, who came there to perform their ablutions in the Ganges. Rajah Jeyſing built the obſervatory in 1794 Sumbut, in two years: he died in 1800 Sumbut. The deſign was drawn by Jaggernaut, and executed by Sadaſhu Mahajin: the head workman was Mahon, the ſon of Mahon a pot-maker of Jeypoor. The Pundit's pay was five rupees per day, the workmen's two rupees, beſides preſents; ſome got lands or villages worth 3 or 400 rupees a year, others money.

VI. *Extracts of two Letters from the Rev.* Edward Gregory, *M. A. Rector of Langar, Nottinghamſhire, to the Rev. Nevil Maſkelyne, D.D. F. R. S. containing an Account of the Diſcovery of a Comet, with Obſervations thereon.*

Firſt letter dated *January* 10*th*, 1793.

THIS comet was diſcovered on the evening of the 8th, in the ſpace between the flexure of the Dragon, and the foot of Hercules. It was about the ſize of a ſtar of the ſecond magnitude, with a coma of white light, hazy and ill defined, but without a nucleus or any appearance of a tail.

At 4*h*..6′..43′ ſidereal time, it paſſed over the meridian under the pole, its zenith diſtance being 75°..16′..16″. At three o'clock in the morning, a very faint, but ſufficiently evident tail was ſeen with the night teleſcope, and the comet had moved a few minutes to the weſt, having increaſed its right aſcenſion and polar diſtance.

On the 9th the comet was again ſeen, but very imperfectly, with the night glaſs, during the twilight. It had moved conſiderably weſtward, and its polar diſtance had increaſed. The tail appeared rather brighter and longer; the coma was not altered, and there was not a nucleus.

Extract from letter *January* 25*th*, 1793.

On January 21ſt, Mr. Gregory obſerved the inſtantaneous immerſion of γ Tauri, at 54′..22″ by his clock, and at 2*h*..3′..31″, he ſaw it again about a minute's diſtance from the moon's enlightened limb. On the ſame day the ſun's paſſage over the meridian was obſerved by a mean of the wires, at 20*h*..18′..45½″, the clock had been loſing a little more than a ſecond a day for eight or ten weeks paſt.* By the mean of ten obſervations of Jupiter's firſt ſatellite, the longitude of the obſervatory is 3′..47″, in time, weſt of Greenwich. Latitude by various inſtruments and obſervations 52°..54′..37″.

The comet's tail ſeen on the morning of the 9th, reached from the center of the glaſs to the circumference towards the zenith, and amounted to about 3½ degrees.

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* Hence the immerſion of the ſtar was at 4*h*..34′..48″..6, and the firſt ſight after immerſion at 5*h*..43′..46″ apparent time. This may determine the longitude of the obſervatory.—Note by Dr. Maſkelyne.

On the 10th, 11th, and 12th, the tail was rather brighter, yet very faint, not broader than a finger, nor brighter than a beam of light, let into an ill darkened room for priſmatic experiments, and was about 4½ degrees long, inclined towards the eaſt; and on the 12th at midnight, due eaſt.

On the 11th it paſſed the meridian under the pole, at 8*h*..28′, ſidereal time. Zenith diſtance 56°..2′..15″.

VII. *Obſervations of the Comet of* 1793, *made by the Rev.* NEVIL MASKELYNE, *D. D. F. R. S. Aſtronomer Royal, and other Obſervers. Communicated by the Aſtronomer Royal.*

1793	Mean time at Greenwich.	Æ of Comet in ſidereal Time.	Æ of Comet in Degrees, &c.	Declination of Comet.	Longitude of Comet.	Latitude of Comet.	Name of Obſervers.
Jan.	H. M. S.	H. M. S.	S. ° ′ ″	D. M. S.	S. D. M. S.	D. M. S.	
8	8 55 7	16 6 43	8 1 40 45	51 46 23 N	7 2 29 3	69 38 5 N	Mr. GREGORY.
11	13 3 50	20 27 56	10 6 59 0	71 1 42 N	1 5 16 0	76 9 8 N	
14	11 38 0	1 12 48	0 18 12 0	45 53 12 N	1 6 16 29	34 53 33 N	Mr. STEPH. LEE.
18	9 26 6	1 58 28,6	0 29 37 9	17 47 7 N	1 3 45 36	5 19 33 N	The Aſtronomer Royal.
21	8 5 52	2 11 42,8	1 2 55 42	9 1 26 N	1 3 47 57	4 0 25 S	
26	6 54 35	2 22 42,23	1 5 40 33	1 48 19 N	1 3 58 51	11 43 25 S	
27	7 37 41	2 24 4,19	1 6 1 3	0 51 36 N	1 3 59 30	12 43 44 S	
28	6 56 35	2 25 18,35	1 6 19 35	0 4 11 N	1 4 1 22	13 34 36 S	
30	8 57 38	2 27 41,4	1 6 55 21	1 20 59 S	1 4 7 13	15 6 48 S	
Feb.							
3	7 11 52	2 31 27,2	1 7 51 48	3 17 27 S	1 4 22 44	17 15 20 S	
4	7 4 12	2 32 17,2	1 8 4 18	3 40 40 S	1 4 27 4	17 41 21 S	
5	7 42 28	2 33 5,13	1 8 16 17	4 2 42 S	1 4 31 19	18 6 6 S	
7	8 5 26	2 34 37.55	1 8 39 23	4 41 11 S	1 4 40 55	18 50 1 S	

Theſe places of the comet may admit of ſome little change, when the ſtars with which it was compared have been ſettled by obſervations with the meridian inſtruments.

VIII. *Account of the Method of making Ice at Benares. By* JOHN LLOYD WILLIAMS, *Eſq.*

ICE is made at Benares during the winter months from water not prepared in any manner, in the following manner; the thermometer not being lower than 35 or ſometimes than 40 degrees of Fahrenheit.

" A ſpace of ground of about four acres, nearly level, is divided into ſquare plats, from four to five feet wide. The borders are raiſed, by earth taken from the ſurface of the plats, to about four inches; the cavities are filled up with dry ſtraw, or ſugar cane haum, laid ſmooth, on which are placed as many broad ſhallow pans, of unglazed earth, as the ſpaces will hold. Theſe pans are ſo extremely porous, that their outſides become moiſt the inſtant water is put into them; they are ſmeared with butter on the inſide, to prevent the ice from adhering to them, and this it is neceſſary to repeat every three or four days; it would otherwiſe be impoſſible to remove the ice without either breaking the veſſel, or ſpending more time in effecting it than could be

afforded,

afforded, where ſo much is to be done in ſo ſhort a time. In the afternoon theſe pans are all filled with water, by perſons who walk along the borders or ridges. About five in the morning, they begin to remove the ice from the pans; which is done by ſtriking an iron hook into the center of it, and by that means breaking it into ſeveral pieces. If the pans have been many days without ſmearing, and it happens that the whole of the water is frozen, it is almoſt impoſſible to extract the ice without breaking the pan. The number of pans expoſed at one time, is computed at about 100,000, and there are employed, in filling them with water in the evenings, and taking out the ice in the mornings, about 300, men, women, and children; the water is taken from a well contiguous to the ſpot. New veſſels, being moſt porous, anſwer beſt.

" It is neceſſary the ſtraw be dry; when it becomes wet, as it frequently does by accident, it is removed, and replaced. I have obſerved water which had been boiled, freeze in a china plate; yet having frequently placed a china plate, with well-water, among the unglazed pans on the ſtraw beds, I found that when the latter had a conſiderable thickneſs of ice on them, the china plate had none. I have alſo wetted the ſtraw of ſome of the plats, and always found it prevented the formation of ice. The air is generally very ſtill when much ice is formed; a gentle air uſually prevails from the ſouth-weſtward about daylight. I had a thermometer among the ice pans, during the ſeaſon of making ice, with its bulb placed on the ſtraw, and another hung on a pole $5\frac{1}{2}$ feet above the ground; and commonly obſerved, that when ice was formed, and the thermometer on the ſtraw was from 37 to 42°, that on the pole would ſtand about 4 degrees higher; but if there was any wind, ſo as to prevent freezing, both the thermometers would agree."

IX. *Account of two Inſtances of uncommon Formation in the Viſcera of the Human Body. By Mr.* JOHN ABERNETHY, *Aſſiſtant Surgeon to St. Bartholomew's Hoſpital.*

THE firſt of theſe occurred in a female infant apparently about ten months old brought for diſſection. It appeared to have been well-fed and ſtrong. The variations of its internal ſtructure from the common are thus deſcribed. " The ſituation of the heart was reverſed; the baſis of that organ was placed a little to the left of the ſternum, whilſt its apex extended conſiderably to the right, and pointed againſt the ſpace between the ſixth and ſeventh ribs. The cavities uſually called the right auricle and ventricle were conſequently inclined to the left ſide of the body; therefore to avoid confuſion in the deſcription, I ſhall, after Mr. Winſlow, term them anterior, whilſt thoſe cavities uſually called left, I ſhall term poſterior. The inferior vena cava paſt, as uſual, through a tendinous ring in the right ſide of the center of the diaphragm, it afterwards purſued the courſe of the vena azygos, the place of which it ſupplied; after having united with the ſuperior cava, the conjoined veins paſſed beneath the baſis of the heart, to expand into the anterior auricle. The veins returning the blood from the liver united into one trunk, which paſſed through a tendinous aperture in the left of the center of the diaphragm, and terminated immediately alſo in the anterior auricle.

" The diſtribution of blood to the lungs, and the return of it from thoſe bodies, were accompliſhed after the uſual manner.

" The aorta, after it had emerged from the poſterior ventricle of the heart, extended its arch from the left to the right ſide, but afterwards purſued its ordinary courſe along the bodies of the dorſal vertebræ.

"From the curvature of the aorta there firſt aroſe the common arterial trunk, which, in this ſubject, divided into the left carotid and ſubclavian arteries; whilſt the right carotid, and ſubclavian, proceeded from the aorta by diſtinct trunks.

"The inferior aorta gave off the cæliac, which, as uſual, divided into three branches; however, that artery which was diſtributed to the liver appeared larger than common; it exceeded, by more than one-third, the ſize of the ſplenic artery of this ſubject. This was the only veſſel which ſupplied the liver with blood, for the purpoſe either of nutrition or ſecretion.

"The vena portarum was formed in the uſual manner, but terminated in the inferior cava, nearly on a line with the renal veins. The umbilical vein of this ſubject ended in the hepatic vein.

"The liver was of the ordinary ſize, but had not the uſual inclination to the right ſide of the body; it was ſituated in the middle of the upper part of the abdomen, and nearly an equal portion of the gland extended into either hypochondrium.

"The gall bladder lay collapſed in its uſual ſituation; it was of a natural ſtructure, but rather ſmaller than common; it meaſured one inch and a half in length, and half an inch in breadth. On opening the bladder, we found in it about half a tea-ſpoon full of bile; in colour it reſembled the bile of children, being of a deep yellow brown; it alſo taſted like bile; it was bitter, but not ſo acridly or nauſeouſly bitter as common bile.

"I diluted a ſmall quantity of this fluid with water, and with this liquor moiſtened ſome paper which had been tinged with a vegetable blue; this was inſtantly changed into a deep green, conſequently this fluid, like common bile, abounded with alkali. I added ſome diluted nitrous acid to a ſmall quantity of this, and of common bile; they both became changed, by this addition, to a ſimilar green colour. The colouring matter of the bile therefore appears to have poſſeſſed its common properties.

"The gall ducts had been divided, in removing the ſtomach and duodenum, before the uncommon termination of the vena portarum was diſcovered, and ſome bile had flowed from the divided ducts.

"The inteſtines did not contain much alimentary or fœcal matter; this was, however, as uſual, deeply tinged with bile.

"The ſpleen conſiſted of ſeven ſeparate portions, to each of which a branch of the ſplenic artery was diſtributed. The other viſcera were found, and of their uſual ſtructure and appearance.

"No cauſe could be diſcovered to which the child's death could be aſſigned. We obſerved that the tongue was incruſted with a dark coloured mucus, which indicated the exiſtence of fever previous to the infant's death.

"The peculiarity of the next caſe, which I have the honour to lay before the Society, conſiſts in an uncommon formation of the alimentary canal. The body of a boy was brought to me for diſſection; it meaſured four feet three inches in length; it was well formed, and had moderately large limbs; they, however, appeared flabby, as if waſted by recent diſeaſe.

"The abdomen was enormouſly ſwoln; which being opened, there appeared a more than ordinary extent of large inteſtines, in a ſtate of great diſtention.

" The diameter of the canal meaſured about three inches, and its dimenſions were neary equal in every part.

" The matter with which it was turgid was of a greyiſh colour, of a pulpy conſiſtence, having little fœtor, and quite unlike the uſual fœcal contents of the large inteſtines.

" The length of the colon was uncommon; having, as uſual, aſcended to the right hypochondrium, it was reflected downwards, even into the pelvis; it then reaſcended to the left hypochondrium, and afterwards purſued its uſual courſe.

" After turning aſide this large volume of inteſtine, to examine the other parts of the alimentary tube, we were ſurpriſed to diſcover that the ſubject contained ſcarcely any ſmall inteſtines. Theſe viſcera, with the ſtomach, lay in a perfectly collapſed ſtate; their texture was extremely tender; they were torn even by a gentle examination. The duodenum, jejunum, and ileum, when detached from the body, and extended, meaſured only two feet in length, whilſt the extent of the large inteſtines exceeded four feet.

" The utmoſt length of the inteſtinal tube, in this ſubject, was little more than ſix feet, whereas it ſhould have been about twenty-ſeven feet, had it born the ordinary proportion to the length of the body.

" I diſtended and dried this curious alimentary canal, and ſtill have it in preſervation.

" As the ſmall inteſtines meaſured only two feet in length, this extent was doubtleſs inſufficient for the preparation and abſorption of chyle; theſe proceſſes muſt therefore have been, in a great degree, performed by the large inteſtines.

" The form and ſtature of the boy ſhew that nutrition was not ſcantily ſupplied; he died evidently from a want of inteſtinal evacuation. Whether the unuſual ſtructure of the canal contributed to the production of diſeaſe, cannot, perhaps, be readily determined; it appears, however, very probable that uncommonly formed parts, although capable of ſupporting life, may be leſs adapted to ſuſtain the derangement of functions conſequent to diſeaſe."

X. *An Account of the Equatorial Inſtrument. By Sir* GEORGE SHUCKBURGH, *Bart. F.R.S.*

THE inſtrument deſcribed in this paper, is placed in the writer's houſe at Shuckburgh, in Warwickſhire. Previous to the deſcription of it, he gives a hiſtory of the inſtruments, made on ſimilar principles, in different ages.

The firſt, by which Ptolemy determined the diſtance between the tropics, is deſcribed, in the 5th book of his Almageſt, under the name of *αστρολαβικον οργανον*, and appears to have conſiſted of two circles at right angles to each other, one repreſenting the ſolſtitial colure, the other the zodiac. The former turned upon an axis parallel to that of the earth, the other on two centers $23^{\circ}\frac{1}{2}$ from the former axis. By this inſtrument, about ſix times as large as the common ring dial, the latitude and longitude of an heavenly body were taken, and it ſeems to have been in uſe from the time of Hipparchus to the ſeventeenth century.*

In a poſthumous treatiſe of Regiomontanus, who flouriſhed about A. D. 1460, to be ſeen in the Britiſh Muſeum, is a pretty full account of the armillary aſtrolabe and the

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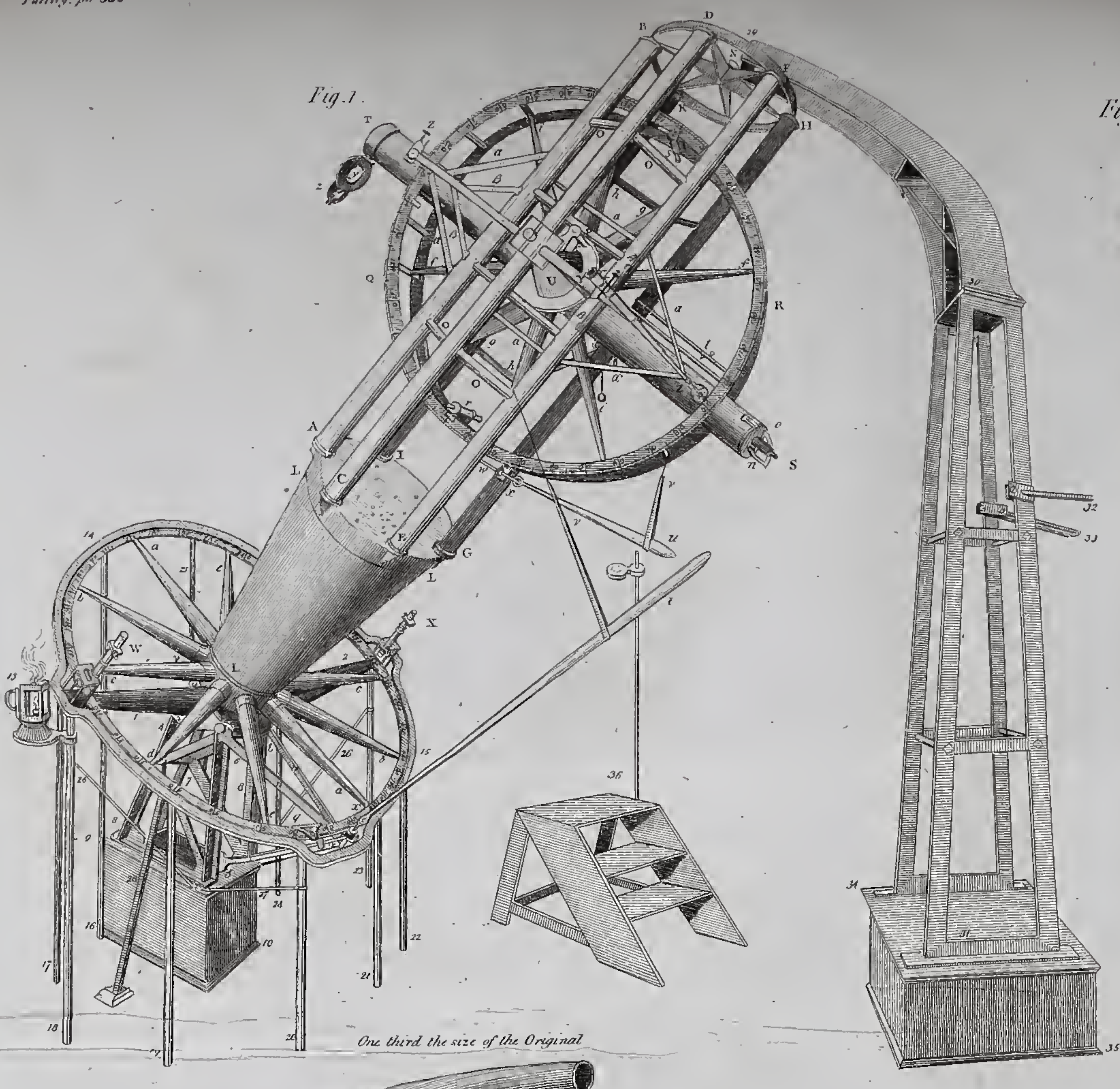
* Vide Weidleri Hiſt. Aſtron. p. 319, et Tychonis Brahe mechanica.

Fig. 1.



One third the size of the Original

Fig. 4.

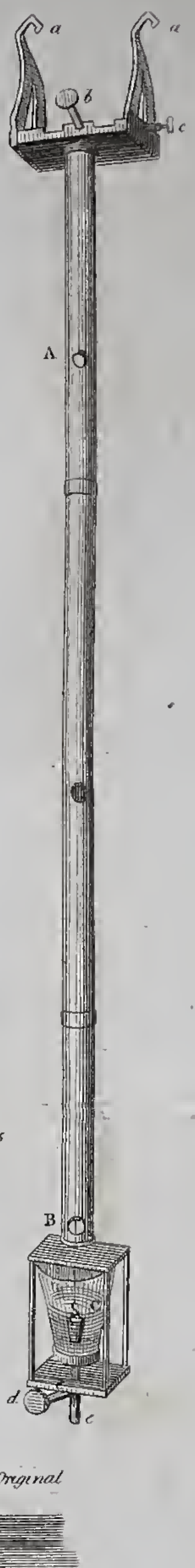


Fig. 2.

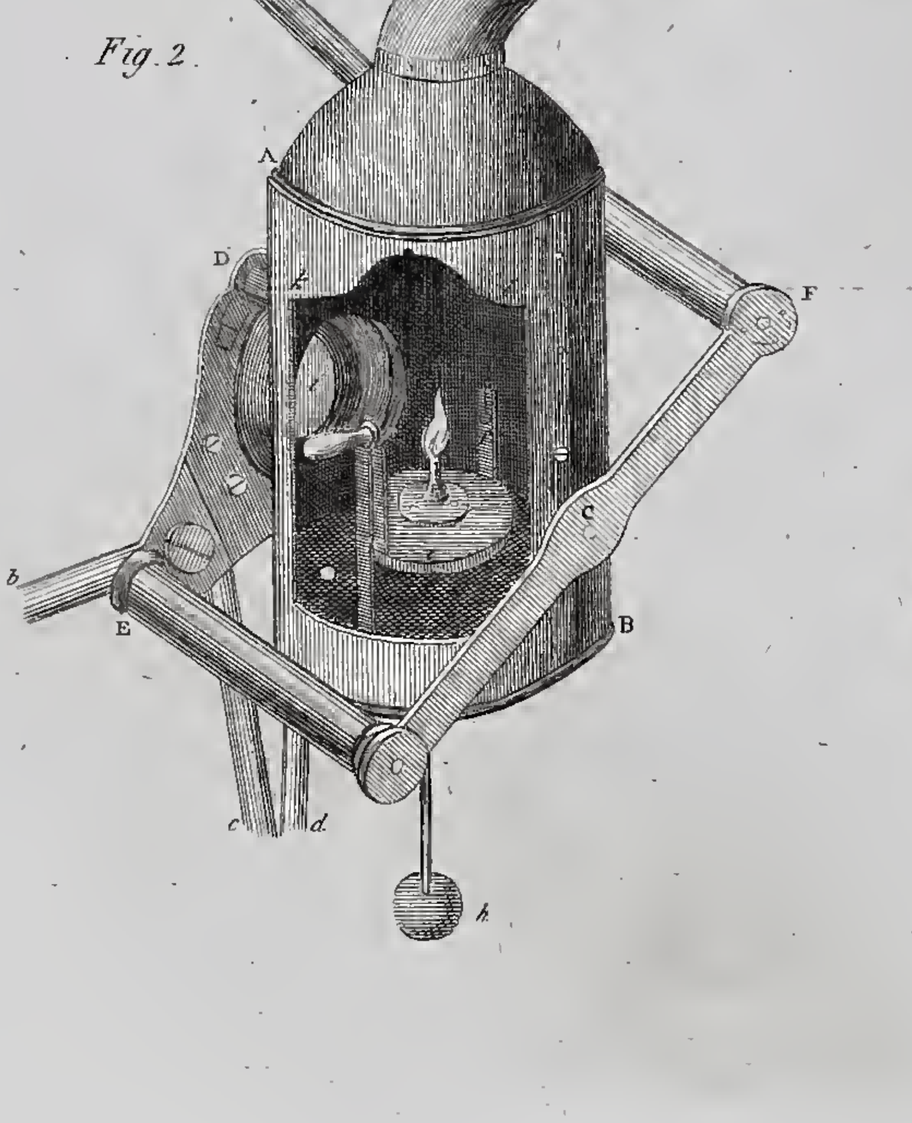
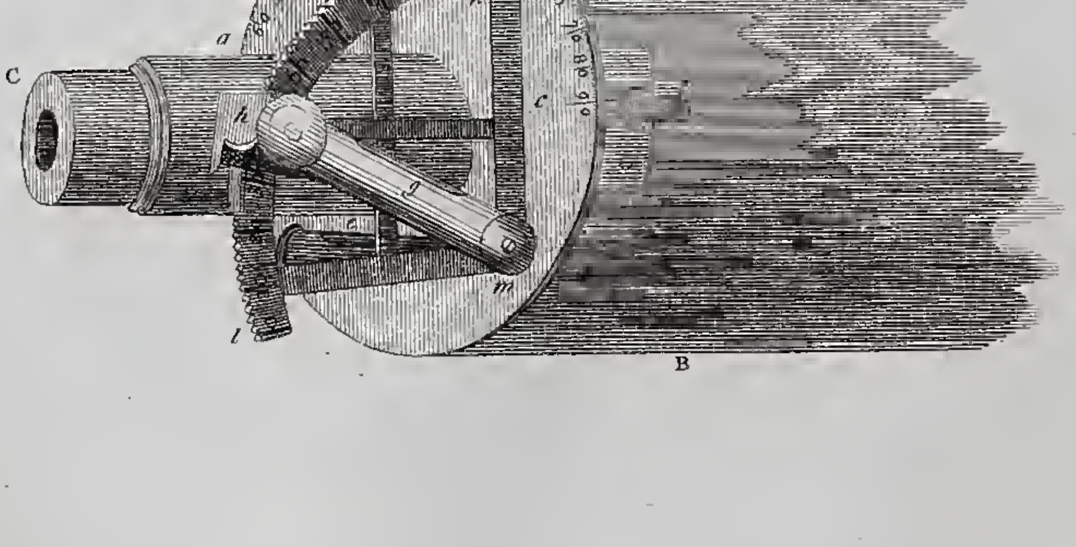


Fig. 3.

One half the size of the Original



the torquetum.* A plate of this latter inſtrument is given by Bailly,† and a deſcription of Ptolemy's aſtrolabe, according to the conception of Regiomontanus, by Weidler.

Copernicus ‡ deſcribes the ſame inſtrument with Ptolemy, though it has a greater number of circles, and in latter times has been called an Armillary Sphere.

In a work of Apian § is a complete deſcription of the torquetum, and a curious letter of Regiomontanus to cardinal Beſſarion, De Compoſitione Meteoroſcopii, or armillary ſphere uſed by Ptolemy.

Tycho Brahe || has given a deſcription and wooden plates of four different aſtrolabes, under the names of armillæ zodiacales et equatoriæ, from 4½ to 10 feet diameter, ſome divided into every 15 or 10 ſeconds, but with only plane ſights. The axis of his 10 feet circle was made hollow.

Chriſtopher Scheiner, ¶ about the year 1620, made uſe of a ſmall teleſcope on a polar axis, with an arc of 47° declination, to obſerve the ſun's diſc, being contrived like the helioſtrate, deſcribed by Deſaguliers,** to follow the ſun with a teleſcope by means of one motion only.

Flamſteed's ſector, deſcribed in the prolegomena to the third volume of his Hiſtoria Cœleſtis, p. 103, can ſcarce come into the claſs of equatorial inſtruments, nor the teleſcopic dial of Molyneux, which, like the ring dial, was only a play-thing for an amateur in aſtronomy.

The ſector †† of Graham, invented about the year 1730 or 1735, differs only from an equatorial inſtrument in the extent of its powers.

Short applied a two feet reflecting teleſcope for the firſt time, to a combination of circles, repreſenting the horizon, meridian, equator, and moveable horary circle, each divided into degrees, and every third minute, with levels for adjuſtment. This inſtrument ‡‡ from want of counterpoiſes, and from the length of the teleſcope, and its high price, was but little uſed.

Ramſden, Nairne, and Dollond reſpectively improved the equatorial inſtrument. Ramſden had made three or four as early as 1770 or 1773; with one §§ of them were made many obſervations, to be ſeen in a memoir on the height of ſome of the Alps, printed in the Philoſophical Tranſactions for 1777. We are thus brought down to the writer's own machine, who, however, firſt gives an account of one abſurdly called a parallactic machine.

Of

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* Scripta clariſſimi Mathematici M. Joannis Regiomontani de Torqueto, Aſtrolabio armillari, Regular magna Ptolemaica, Baculoque aſtronomico, etc. etc. 4to. Nuremberg, 1544.

† Aſtronomie Moderne Tome I. p. 687.

‡ De revolutione orbium cœleſtium lib. 2. c. 14. De exquirendis ſtellarum locis.

§ Introductio geographica Petri Apiani in doctiſſimas Verneri annotationes, &c. &c. cui recens jam opera P. Apiani acceſſit Torquetum, inſtrumentum pulcherrimum ſane et utiliſſimum. Fol. Ingolſtadii. 1533.

|| Aſtronomiæ inſtauratæ mechanica. Noribergæ 1602.

Hiſt. Cœleſtis, Lib. Prolegom. Tychonis Brahei, Auguſtæ Vindilicorum. 1666. II. Vol. Fol. p. 118, 119.

¶ Roſa Urſina. Fol. Bracciani. 1630. p. 347.

** Mathematical elements of natural philoſophy. lib. 5. c. 2.

†† See Smith's Optics. Vol. II. §. 885, and Vince's Aſtronomy.

‡‡ See account of this machine in the Philoſophical Tranſactions for the year 1749, in which it was invented.

§§ See an account of this equatorial in Vince's practical aſtronomy, p. 152. Of Nairne's, in the Philoſophical Tranſactions for 1771. Dollond printed an account of his, in 1772 or 1773.

Of this a deſcription and plate has been given by Caſſini.[*] It was a frame of wood ſupporting a polar axis, with an equatorial and declination circle, of only a few inches in diameter, *i. e.* a bad ſtand to a refracting teleſcope of 8 or 10 feet, giving it a motion parallel to the equator. Hence it was called Machine parallactique, by the miſtake of παραλλακτος for παραλληλος. A machine of the ſame name is deſcribed by De la Lande,[†] and there was one made by Megnie for the preſident De Saron, and in 1778, a ſmall inſtrument of the ſame kind was in the poſſeſſion of William Ruſſel, F. R. S. made by Bird.

The equatorial inſtruments,[‡] hitherto made, were unfit, either from the ſmallneſs of their dimenſions, or defect of their conſtructions, for the accuracy of modern aſtronomy; and here it may be remarked, that, from the time of Hipparchus, to the age of Walther and Copernicus, few obſervations can be depended on, to within leſs than 5, 8, or perhaps 10 minutes, except thoſe of Tycho Brahe, whoſe are within leſs than one minute. The errors of Hevelius's large ſextant of 6 feet radius, were 15 or 20 ſeconds; of Flamſteed's, 10 or 12 ſeconds; of Graham's mural quadrant of 8 feet radius, uſed by Bradley, 7 or 8 ſeconds.

The inſtrument now to be deſcribed was made by Ramſden. Six columns AB, CD, EF, &c. (See Plate XIX. Fig. 1.) $3\frac{1}{2}$ inches in diameter, and 5 feet 10 inches long, hollow of braſs, are fixed to a circle of bell metal, B, D, F, H, and to truncated hollow cone, LLL, of braſs, 2 feet high, and at AG, 1 foot 9 inches diameter. The tubes O,O, P,P, are to prevent the columns from bending. Theſe parts conſtitute the axis, which terminates in a ſteel cone, reſting in a hollow conoid of bell metal, ſo that the place of bearing and friction, is about two tenths of an inch from the extremity of the cone; the other end of the axis is a cylindrical pivot N, $1\frac{1}{4}$ inch long, and an inch in diameter, turning in a Y of bell metal. This axis is 8 feet 4 inches long, ſupported by an iron frame, 3, 4, 5, 6, 7, 8, fixed below the floor into brick work, and incloſed to about a foot high, by a mahogany caſe 9, 10. The pivot N reſts on pieces of caſt iron, $2\frac{1}{2}$ inches wide, and $\frac{1}{2}$ inch thick, 29, 30, 31, ſtanding 10 feet above the floor, and connected with the walls by iron bars, 32, 33. The lower part is fixed into brick work, and the bottom is ſhut up in a box of mahogany, 34, 35. At the lower end of the axis LN, are inſerted 10 braſs cones, *aa*, *bb*, *cc*, &c. radii to a graduated braſs circle $49\frac{1}{2}$ inches diameter, at right angles to the axis, having two ſets of diviſions, one of points, and one of lines, each into degrees of 10 minutes, the other minutes and ſeconds being read off by the microſcopes W and X, with a moveable wire and micrometer ſcrew.[§] This circle is incloſed in a frame of mahogany, 14, 15, ſupported by 10 baluſters, 16, 17, 18, &c. At 13 is a ſmall lamp, which by reflection from the ſpeculum in the microſcopes, throws light on the diviſions. 1 and 2 are ſtout braſs cones, firmly fixed in the frame to ſupport the microſcopes. γ, δ, is a plane forming the upper ſide of the frame 3, 4, 5, 6, &c. conſiſting of three plates, two moveable in grooves, the other fixed, furniſhed with ſcrews, one giving the extremity of the axis a motion upward or downward, the other a motion to the right or left: the latter motion is procured by a rod paſſing through the cone 2, one end ſcrewing into the plate below L, near the center, the other turned by an handle fixed on near X; the former motion is made by a handle fixed on to a ſcrew near *ε*.

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[*] See hiſtory of the academy of ſciences at Paris, for 1721, p. 18; and for 1746, p. 121. Dictionnaire de Mathematique par Mr. Saverien. 2 Tom. 4to. 1753, or Owen's dictionary of arts and ſciences, 4 vol. 8vo.

[†] Aſtronomie. Vol. II. § 2004. 2409.

[‡] Except two large equatorial ſectors made by Siſſon for Greenwich obſervatory, and one by Ramſden for Roy, whoſe circles are about 30 inches in diameter.

[§] See account of this inſtrument by Roy, in the Philoſophical Tranſactions. Vol. LXXX. p. 145.

Q, R, a circle of the ſame dimenſions, and graduated as the former; has eight conical radii ſcrewed to a circular center piece, the baſe of a large conical axis 2 feet 3 inches long, of which one ſide is ſeen at U, and its extremity with ſliding plate and ſcrews for adjuſtment at V. Paſſing through this axis at right angles is the teleſcope T S, $5\frac{1}{2}$ feet long. At Y and Z are two microſcopes, furniſhed like thoſe in the equatorial circle, Y Z being ſeen at full length, the other at Z being foreſhortened. *α*, *α*, *α*, &c. an hexagonal lozenge of braſs fixed to the columns, A B, and E F, to ſupport the microſcopes at the lower, as *β*, *β*, *β*, do at the upper end. At P is a ſpirit level, paſſing through the center plate of the conical axis at right angles to the teleſcope, ſupported by a cock *k* at each end; by means of a ſmall toothed wheel and pinion, the level is made to revolve round its own axis, ſo that, in any poſition of the circle, the ſame ſide of the level may be brought uppermoſt. *l*, *m*, is a braſs tube incloſing a ſtiff iron rod, turning upon two fine ſteel points, adjuſted by proper ſcrews, parallel to the line of ſight of the teleſcope: the rod is attached to a ſpirit level, lying below it. At S is a particular apparatus, to correct the effects of refraction and parallax, compoſed of two levels, a ſmall quadrant *n*, *o*, and a ſemicircle divided with its nonius, to every five ſeconds, on the breech plate of the teleſcope, the exterior eye tube having a circular motion by a wheel and pinion at *o*, independent of the tube carrying the croſs wires. *t* and *u* are handles to a hook's joint at *x*, *x*, turning an endleſs ſcrew at *w*, *w*, to give a motion to the teleſcope in right aſcenſion or declination. *r*, *s*, are microſcopes at right angles to the line of ſight, of uſe only when the plumb line is uſed in preference to the level *l*, *m*, either for adjuſting the inſtrument, or obſerving a meridian altitude. *y*, *z*, thin perforated braſs plates, by which the aperture of the object glaſs may be changed to $\frac{1}{2}$ or $\frac{1}{4}$. There are three vertical and one horizontal croſs wires within the eye tube S, with proper ſcrews, and enlightened by a lamp fixed to the end of the declination axis, oppoſite V, which throws its light through the conical axis, perforated for that purpoſe, on a ſpeculum in the center of the teleſcope, placed at $\frac{1}{2}$ right angle to the axis of the object glaſs.* From this view of the inſtrument it is evident, that, when L N is directed to the pole, the circle 14, 15 correſponds with the equator, and Q R becomes an horary circle, and by knowing the hour, the true place of an object in the heavens may be found.

In Plate XIX. Fig. 2. is repreſented the lamp fixed to the farther end of the declination axis. A B, the braſs caſe, ſuſpended on two centers C, D, in the frame E, F, attached to the pillars I K, G H of the equatorial, by cylindrical braces, *a*, *b*, *c*, *d*. The lamp *e* ſwings on centers *f*, *g*. G the chimney, *i*, a convex lens, tranſmitting the light to the perforated ſpeculum, and it is aſſiſted by another convex lens at the end of the axis, before which is at times ſcrewed on a pale green glaſs to temper the light of the lamp, ſo that the ſtars are ſeen on a pale green field, and the wires appear black. The center D reſts on three friction wheels, and at *k*, *l*, *m*, *n*, is a ſliding door to keep out the wind.

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* See Vince's aſtronomy. p. 80.

Plate XIX. Fig. 3. repreſents the refraction piece. A B, a portion of the teleſcope. C the eye tube. *a, b, c,* a divided ſemicircle; *d* its nonius fixed to A B. *e* a ſmall ſpirit level, moving by means of ſcrew *f,* with the engraved ſemicircles to which it is attached. *l, k,* a ſmall quadrant of altitude, with a level *g,* turning on the center *m.* *i* an aperture for a key to give a lateral motion to the wires; *f* a ſcrew to make them parallel to the equator and declination circle.

Plate XIX. Fig. 4. repreſents the plumb line 5 feet long; ſuſpended to the roof of the obſervatory by two hooks *a, a,* and inſerted in a braſs tube A B. *b, c,* two adjuſting ſcrews, moving a ſliding plate, to which is fixed the upper end of the plumb line: *d* a ſcrew to raiſe or depreſs the glaſs of water in which is the plummet C.

The equatorial is placed in a building conſtructed on purpoſe for it. The arch, on which it reſts, is filled with ſolid maſonry to a conſiderable height, ſo that the machine reſts as it were on a rock,* and the boarded floor has no connection with the inſtrument.

In this obſervatory is a clock or ſidereal regulater, which ſhews the degree and minute of the equator on the meridian, at any given inſtant without reduction. The vibrations of the pendulum are $\frac{2}{3}$ only of a common pendulum $= 10''$ of ſpace: and the index, carried round immediately by it, deſcribes in one revolution $10'$ of ſidereal ſpace; the next index from the center of the plate, ſhews the degrees and every 10th minute, making a revolution in 10°: and the decades of degrees, from 1 to 36 = 360° are ſhewn in the opening uſually appropriated in common clocks to the days of the month. The pendulum 17 inches $\frac{4}{10}$ long, is compoſed of five rods, the center and two exterior being of iron, the other two compounded of ſilver, braſs, and zinc; the ball weighs 6 pounds, the clock weight 32. The clock goes five months with once winding up, and does not vary its rate between winter and ſummer more than three ſeconds a day ſidereal time.

At the diſtance of 2970 feet from the center of the obſervatory, is a ſolid brick pier, 8 feet high, 9 feet by 2 feet 3 inches at bottom width, and 4 feet by 1 foot 6 inches at top. On the top is an iron box 8 inches ſquare, and 1 foot high, excluſive of the chimney, in which is an Argand's lamp ſhining through a circular aperture, covered by a piece of glaſs, ground rough on one ſide, that through the teleſcope reſembles the diſc of a planet $7'\frac{1}{2}$ in diameter. Around this aperture is painted a circle of black, in diameter 3 inches, ſubtending an angle of $18''$. Thus this aperture is a meridian mark by day and night. A plumb line ſuſpended from the top, and playing near a mark on the top of a poſt driven into the ground at the bottom, is to mark any deviation, which muſt be improbable in ſo ſtrong a building, from the perpendicular.

Plate XVIII. Fig. 5. 1, 2, are the extremities of the axis of the circle of declination; A, a ſection of the tube of the teleſcope; 3, 3, the level tube, turning on an axis *d, e.* 4, 4, 5, 5, ſupporters; *g* a toothed wheel, moved by pinion *f,* turned by the ſcrew *b*; *a* an adjuſting ſcrew to bring the level parallel to the axis 1, 2: *c* another, to bring it it parallel to the axis *d, e*: *h* another, to bring the tube of the level parallel to its axis *d, e*: *i* another, to make this axis parallel to 1, 2. The circumferences of theſe ſcrews are divided into ten known parts, ſo that the angle of motion given at any time is known: *k*, *l*, moveable indexes, ſet at each end of the bubble. The tube is about 14 inches long; by an inclination of 15″, the bubble moves $\frac{1}{10}$ inch, and the third or fourth part of this ſpace is plainly diſcernible.

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* The machine, weighing near 30 tons, reſts on an arch of which the bricks were laid dry, and then grout of gravel and hot lime was poured upon them; two years after the haunches were filled up with bricks laid in mortar.

The parts of the ſwinging level *l*, *m*, fixed to the tube of the teleſcope, are ſeen in (Plate XVIII. Fig. 6.) A B is one ſide of the tube of the teleſcope, C, D, E, F, upright ſupporters fixed on it, G, H, I, the level, 12 inches long, ſwinging on two conical centers *a*, *i*, of poliſhed ſteel. G, I, an hollow braſs tube, ½ inch diameter, in which is a ſteel triangular axis, terminated at *a*, and by means of a ſpiral ſpring winding round it, its length is contracted by pulling the trigger *g* towards I, ſo that the center *a* retires within the tube G I, in caſe it is neceſſary to reverſe the level. *c* a ſcrew to keep the axis *a*, *i* parallel to *b*, *b*: *d* another to keep this axis parallel to A B: *h* a third to keep it parallel to the line of collimation eaſt and weſt: *e*, *e*, indexes marking each end of the bubble, moveable by ſliders *f*, *f*.

Among the advantages of this inſtrument is the uſe of a circle, inſtead of a quadrant or ſextant, by which means the error of the center, common in quadrants, is done away, and the error in each individual diviſion is diſcovered. For the latter purpoſe, the index wires in the oppoſite micrometers were made an exact diameter to the circle, and each diviſion was compared with the oppoſite correſponding one. The differences were expected to be found ſomewhere = 0″, 0 in the diameter paſſing through the true center of the circle, and the center of the pivot of the whole machine, and at right angles to this to be a maximum: in other places, the eccentricity would be as the co-ſine of the diſtance from that point, where it was a maximum. The circle was thus examined, the diameter of the points of the arch being firſt found to be about 21″, and the thickneſs of the wire = 12″: the wire of the eaſt microſcope was placed to biſect the diviſion of 360°, and the ſcrew being then adjuſted to zero ° of the diviſions of the head, every 10th degree of the circle was made to paſs under the wire, and the diviſion under the wire of the weſt microſcope was noted. The reſult is ſeen in the adjoined table.

1ſt column ſhews the point under the eaſt wire. 2d column ſhews how much the oppoſite point differed from weſt wire. 3d column ſhews the mean difference = double the error of the center + ſum of errors of the two diviſions. 5th column contains the numbers in the 3d column, corrected by ſubtracting 0″, 9 a quantity, by which on taking the mean of all the numbers in the third column, the weſt micrometer was found too forward on the circle. 6th column gives half of the preceding difference, and = the ſimple error of the diviſions.

Table of the Diviſions of the Equatorial Circle.

1	2	3	4	5	6
Eaſt micro-ſcope.	Weſt mi-croſcope, and difference.	Mean diffe-rence.	Diffe-rence of the mean from the extremes	Column 3d cor-rected.	Simple error.
° ′	°	″	″	″	″
360 0	180. + ″0,0 1,2 0,7 1,0 0,6	+0,7	0,5	−0,2	−0,1
360° 0′ repeated	+0,4 0,8 0,9	+0,7	0,2	−0,2	−0,1
360° 0′ repeated	+0,8 0,2 0,0 0,5	+0,4	0,4	−0,5	−0,25
mean of theſe three		+0,6			
° ′ 10 0	° 190.				
	+ ″1,5 2,6 2,7	+2,3	0,8	+1,4	+0,7
20 0	200. +1,0 0,7 1,0	+0,9	0,2	0,0	0,0
30 0	210. +3,1 4,1 4.0 3.9	+3,8	0,7	+2,9	+1,45
40 0	220. +4,2 3,9 4,2	+4,1	0,2	+3,2	+1,6
50 0	230. +1,6 1,5 1,5	+1,5	0,1	+0,6	+0,3
60 0	240. +2,8 3,6 3,6	+3,4	0,6	+2,5	+1,25
70 0	250.* +3,2 3,0 2,0	+2,7	0,7	+1,8	+0,9
80 0	260. + ″3.4 3,5 3,8	+3,6	0,2	+2,7	+1,35
90 0	270. +0.8 0,8 1.7	+1,1	0,6	+0,2	+0,1
100 0	280. +1,5 2,2 2,4	+2,0	0,5	+1,1	+0,55
110	290.* +0,7 −1,2 −1,7	−0,7	1,0	+1,6	+0,8
111	291. +0,8 1,5 0,4	+0,9	0,6	+0,0	0,0
120	300. −0,5 −0,7 +0,5	−0,2	0,5	−1,1	−0,55
130	310. +0,7 −0,5 −1,0	−0,3	1,0	−1,2	−0,6
140	320. −2,7 −1,6 −2,3	−2,2	0,6	−3,1	−1,55
150*	330. −0,4 +0,7 +1,0	+0,4	0,8	−0,5	−0,25
160	340. −2,2 −1,2 −2,0	−1,8	0,4	−2,7	−1,35
170	350. −1,6 −2,2 −1,7	−1,8	0,4	−2,7	−1,35
Mean of all		−0,9	0,53		

Thoſe with * are doubtful or bad points.

From an inſpection of the table, it appears, that taking together the errors of the diviſions, inequality of the points, imperfection in reading off, or a little play in the ſcrew of the micrometer, they did not amount to 2″, the greateſt error that will ariſe in an obſervation when only one microſcope is uſed, and probably only half of that error will take place.

Table of Obſervations of the Diviſions of the Declination Circle.

1ſt microſcope next the eye.	Fartheſt microſcope next the object glaſs.	Mean difference.	Difference of the mean from extreme.	Simple error.
Div. from S. pole.		″	″	″
10° 0′ ″ + 0,2 − 0,2 − 0,3 + 0,3	10° 0′ ″ − 0,3 − 1,0 + 0,7 − 0,3	− 0,1	− 0,9	− 0,05
Mean 0,0				
20 0	20 0 − 0,1 − 0,5 − 1,2	− 0,6	0,6	− 0,3
30	30 0 − 0,5 − 1.5 − 0,7	− 0,9	0,6	− 0,45
40	40 0 − 1.0 − 0,9 − 2,0	− 1,3	0,7	− 0,65
50*	50 0 − 2,6 − 3,7 − 2,8	− 3,0	0,7	− 1,5
52° 10′	52° 10′ + 4,4 + 5,2 + 4,5	+ 4,7	0,5	+ 2,35
60*	60. − 1,5 − 1,0 + 0,4	− 0,7	0,8	− 0,35
70	70. − 1,4 − 2,0 − 2,6	− 2,0	0,6	− 1,0
80*	80. + 2,4 + 3,1 + 2,6	+ 2,7	0,4	+ 1,35

1ſt microſcope next the eye.	Fartheſt microſcope next the object glaſs.	Mean difference.	Difference of the mean from extreme.	Simple error.
90° 0′	90° 0′ ″ − 1,0 − 0,2 − 0,8	− 0,7	0,5	− 0,35
100	100 + 1,9 + 0,4 + 0,5 + 1,0	+ 0,9	1,0	+ 0,45
110	110 + 0,5 + 0,6 − 0,2	+ 0,3	0,5	+ 0,15
120	120 − 0,5 + 0,7 + 0,4	+ 0,2	0,7	+ 0,1
130	130 − 0,9 − 0,6 + 0,3	− 0,4	0,7	− 0,2
140*	140 + 0,2 − 0,1 + 0,7	+ 0,3	0,4	+ 0,15
150*	150 − 0,4 − 0,3 − 0,5	− 0,4	0,1	− 0,2
160	160 − 0,1 + 1,2 + 0,2 + 0,7	+ 0,7	0,6	+ 0,35
170	170 + 1,2 + 0,4 + 0,3	+ 0,6	0,6	+ 0,3
180	180 + 0,4 + 0.6 + 0,4	+ 0,5	0,1	+ 0,25
Mean of all		+ 0,04	0,57	

* Denotes a doubtful or bad point.

By the above table of obſervations, it appears, that the diviſions of the declination circle are little, if at all, inferior in accuracy to thoſe on the equatorial circle, and to the credit of Berge, Ramſden's workman, this inſtrument is not to be equalled in accuracy by any one in Europe.

The object glaſs of the teleſcope is a well corrected double achromatic, focus 65 inches, aperture 4,2 inches. There are two ſets of eye glaſſes, one ſingle, the other double: 6 of the latter with powers from 60 to 360, and five of the former with powers from 150 to 550; a priſm eye tube, with a power of 100, for objects near the zenith or pole;[*] and a tube with a divided eye glaſs micrometer power 80, but the images not being diſtinct and the ſcale not more than 10′, it is of little uſe.[†]

For the adjuſtment of the inſtrument, 1ſt. of the level P, *k*, parallel to the declination axis, U, V, the following method is uſed.[‡] The polar axis being placed in the meridian, by means of the meridian mark, and elevated to the latitude of the place; the axis of the declination circle is, by its proper level, brought nearly horizontal, and the inſtrument turned round about 180°. If the bubble does not ſtand true, correct half the error by moving the equatorial circle by its handle *t*, and the other half by the ſcrew *a*; then turn the inſtrument to its former poſition, and if the level does not ſtand true, repeat the operation till it does. Now turn the declination circle 180°, till the level is below the axis, and by the pinion *b*, reſtoring the tube of the level to an upright poſition, ſee if the bubble ſtands true, if not correct $\frac{1}{2}$ the error by the ſcrew *c*, and the other $\frac{1}{2}$ by *a*; then turn the declination circle 90° each way, and correct $\frac{1}{2}$ by the ſcrew *h*, and $\frac{1}{2}$ by the ſcrew *i*. If the bubble ſtands true in every part of a revolution, the axis of the declination circle and level are parallel to each other, and the adjuſtment is compleat.

2d. To ſee whether the line of ſight is at right angles to the declination axis, and this latter to the polar axis; take the error of collimation of the teleſcope in right aſcenſion by a ſtar in the equator, and correct it by the ſcrews at the high end of the teleſcope. The declination axis being brought to an horizontal poſition, and the center wire of the teleſcope biſecting the meridian mark, the teleſcope becomes a complete tranſit inſtrument. Next find the error of collimation in right aſcenſion by a circumpolar ſtar, and correct it by ſcrews at one end of the declination axis.

For the adjuſtment of the croſs wires, obſerve, while a limb of one of the planets runs along the equatorial wire, whether any motion of the eye upwards or downwards alters the relative place of the image and wire; in the former caſe, if the planet moves in the ſame direction, the wires muſt be puſhed in, and *vice verſa*. To ſecure the permanent poſition of the object glaſs, two correſponding marks ſhould be made on the cell into which the glaſs is burniſhed, and the tube of the teleſcope, ſo that on taking it out, it may be reſtored again to its proper place.

To meaſure the interval between the wires, obſerve the paſſage of a ſtar in the equator by the clock, or one out of it by making proper allowance for declination, or it may be done by means of the equatorial circle and a land object. By theſe methods the intervals of the three wires was found to be $7'..34'',5 = 30'',3$ ſidereal time.

For the hanging level, move the declination circle about its axis, till the bubble *l*, *m*, ſtands true, and fix it by the clamp *w*, reverſe the level by turning it end for end, and if the bubble now ſtands true, it is adjuſted, if not correct $\frac{1}{2}$ the error by the declination handle, and the other $\frac{1}{2}$ by the ſmall ſcrew at the bottom of the level, then reverſe the level, and repeat the operation till it ſtands true. Then ſee what land object is covered by the horizontal wire, turn the teleſcope 180° round the declination, and 180° round the polar axis; and if the ſame object is now covered by the horizontal wire, the axis of the level is adjuſted parallel to the line of collimation in a vertical direction, if not correct half the error by the ſcrew at the bottom of the cock, that ſupports one end of the axis of the level, and the other half by the declination handle: invert the teleſcope, and repeat if neceſſary the operation as before.

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[*] See Philoſophical Tranſactions, Vol. LXXX, p. 155.

[†] See Philoſophical Tranſactions, Vol. LXIX.

[‡] See Boſcovici opera pertinentia ad aſtronomiam et opticam. 4to. Baſani, 1785. Tom. 4ti. Op. 1 m.

For the index wires of the microſcopes, place the declination axis in an horizontal poſition, and let the index wires in the two equatorial microſcopes W X biſect the oppoſite diviſions 360° and 180°. Then bring 90° under its microſcope, and turn the inſtrument a quarter round on the polar axis, and if the bubble of the hanging level is true, the index wire of the declination microſcope is correct; if not, correct half the error by the declination handle *u*, and half by the little ſcrews *h*; then bring 270° on the equatorial circle under the micrometer wire, and if the level reſts true, the adjuſtment is made; if not, repeat the operation, then let the index wire of the declination micrometers biſect 90 and 90°.

For the refraction piece, point the teleſcope in the meridian to the horizon, then by the pinions *f*, *h*, make the level *e* and *g* reſt true, move the nonius *d* to 0,0′, and that of the little quadrant of altitude *l*, *k*, to 0,0′.

For the magnifying power and ſcale of the microſcopes, puſh in, or draw out the tube that carries the micrometer and eye glaſſes, but re-adjuſt the object glaſs of the microſcope to diſtinct viſion by the ſcrew of the cell, till the image and wires have no relative change of place, by any motion of the eye.

To make the ordinary obſervations of right aſcenſion and declination, adjuſt the teleſcope to the meridian mark, to be biſected by the middle wire, and mark the diſtance of the index wires of the equatorial micrometers from 360° and 18°. Move then the inſtrument about the polar axis by its handle *t*, till 360° and 180° are biſected by the equatorial wire, move the declination circle by its handle *u*, till the hanging level ſtands true, and not the diviſion on this circle cut by the micrometer wire. The inſtrument is now prepared for an obſervation over the meridian, and alſo of the polar diſtance; but if the obſervation is made out of the meridian, the altitude, and angle of the horary and vertical circles, muſt be taken by the refraction apparatus.

The accuracy of this inſtrument has been determined by an experience of more than twelve months. The paſſage of a ſtar near the equator over any wire, may be determined within $\frac{1}{3}$ of a beat of the regulater, or $3'',7$, and from a mean of the three wires within $1'',25 = \frac{1}{12}$ of a ſecond of time in favourable weather. From the obſervations of the ſun's diameter, it appears, that the error may be expected within 3′; that it is 17 to 1 it does not amount to 5″, or $\frac{1}{3}$ of a ſecond of time. Hence

The probability of error in obſerving a tranſit over the meridian, from a mean of three wires, is about - - - -	2″..0
Error in ſetting the teleſcope to meridian mark - -	1..0
Error in reading off the equatorial microſcope - - -	,5
Total error - - - - - -	3..5

Add error of the diviſions at the center - - - - 1..0
Second reading off of the microſcope - - 0,5

Total error of tranſit out of the meridian - - - 5..0
By actual experiment in 13 trials within 15° on each ſide of the meridian in February, 1792 - - - - - - 7..5

In the obſervation of a polar diſtance.

Error of the eye in eſtimating the coincidence of the wire in the teleſcope with the object, power 60 - - - - 1",
Error of diviſions and center in taking the horizontal point in the circle 1
Error in reading this diviſion by the microſcope - 0,5
Error of the level - - - - - 2,
Error of diviſions and center, a ſecond time, in taking the angle of the polar diſtance - - - - - - 1,
Error in reading off this diviſion by the microſcope - - 0,5

Total - - - - - - 6,0
The ſame from various experiments - - - - 7,5
And it is ſuppoſed, that with care no error in the polar diſtance need be apprehended above - - - - - - 7"
And in the meridian paſſage above - - - - 3,5

From which ſtatement it appears, that the future obſervations of this writer, will be entitled to a degree of credit, which very few poſſeſſors of ſimilar inſtruments have reaſon to expect.*

XI. *Additional Obſervations on the Method of making Ice at Benares. By Mr.* WILLIAMS.

"APRIL 30th, 1792, the thermometer, in the ſhade, being at 95 degrees, ſome water was taken up from a well, ſixty feet deep, and the thermometer being immerged in it, its temperature was found to be 74 degrees. This water was then poured into four pots, or pans, ſimilar to thoſe which, in my former letter, I mentioned as being employed in the proceſs for making ice. They were alſo ſimilar to each other in ſize and conſtruction, except that two of them were new and unglazed, and the two others old, with their pores cloſed, ſo that no moiſture could tranſpire through them. Theſe pots were then expoſed to a hot weſterly wind, in the ſhade, for the ſpace of three hours; viz. from two o'clock in the afternoon till five. Upon examining them at that time, the water in the old pots was found to be at 84 degrees, and that in the new, or porous ones, at 68. After remaining in that ſituation one hour longer, the water in the old pots roſe to 88 degrees, whilſt that in the new ones continued at 68.

" May 1ſt, at two o'clock in the afternoon, the thermometer then being, in the ſun, at 110 degrees, and in the ſhade at 100, the experiment was repeated, with the ſame pots as before. After being filled with well-water, they were expoſed for four hours, viz. from two o'clock till ſix, to a hot wind; the water in the old pots was then found to be at 97 degrees, that in the new ones at 68.

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* The writer has added ſeveral tables for the correction of refraction, parallax, meridian line, and other things, relating to the equatorial, which as few perſons are in poſſeſſion of ſuch an inſtrument, and many of the tables are to be had elſewhere, it was not thought neceſſary to inſert in a work, profeſſing only to abridge what is moſt curious in the labours of others.

"The foregoing obſervations on the frigorific effect of evaporation from porous veſſels, will perhaps account, in ſome meaſure, for ice being formed when the thermometer, in the air, is above the freezing point. And the power of evaporation in generating cold, may be further elucidated by the following obſervations on the effects produced, by its means, in our houſes.

May 16, 1792, at two in the afternoon,

The thermometer, in the ſun, with a hot weſterly wind, roſe to	118 degrees.
Ditto, in the ſhade, but expoſed to the hot wind - -	110 ditto.
Ditto, in the houſe, which was kept cool by *tatties* - -	87 ditto.

June 7.

Thermometer, in the ſun - - - - -	113 degrees.
Ditto, in the ſhade, and hot wind - - - -	104 ditto.
Ditto, in the houſe, cooled by *tatties* - - - -	83 ditto.

"*Tatties* are a kind of mat, made of freſh green buſhes, or long roots, like ſnakeroot; they are affixed to the door or window frames, and kept conſtantly ſprinkled with water. The degree of cold produced by their means is ſuppoſed to be in proportion to the heat of the wind which paſſes through them, as on that depends the quantity of evaporation."

METEOROLOGICAL JOURNAL.

1792.	Thermometer without.			Thermometer within.			Barometer.			Hygrometer.			Rain.
	Greateſt height.	Leaſt height.	Mean height.	Greateſt height.	Leaſt height.	Mean height.	Greateſt height.	Leaſt height.	Mean height.	Greateſt height.	Leaſt height.	Mean height.	
	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Inches	Inches	Inches				Inches
January	53	19	37,2	57,5	43	51,1	30,47	28,94	29,66				1,810
February	56	16,5	40,0	60	43	52,6	30,40	29,53	29,98				0,712
March	56	26	44,3	61	46	54,3	30,51	29,07	29,77	85	48	64,3	1,791
April	66	38	52,0	65,5	54,5	59.3	30,32	29,12	29,90	75	44	59,6	1,550
May	67	42,5	53,3	63	54	58,2	30,39	29,32	29,97	72	43	56,7	1,624
June	79,5	49	58,1	65	59,5	61,6	30,27	29,41	29,93	67	40	57,7	1,624
July	76	53	61,7	69	63	64,8	30,19	29,52	29,88	80	46	60.9	2,299
Auguſt	84	54	65,7	74	64	68,5	30,30	29,40	29,93	80	45	59,1	2,065
September	69	42	55,1	65,5	55	60,5	30,34	29,09	29,79	81	48	60,5	1,910
October	63	39	51,0	61,5	56	58,3	30,42	29,26	29,79	84	58	69,8	1,884
November	58	35	45.5	63,5	52	56,9	30,44	29,32	30,02	84	59	68.9	0,454
December	53	31,5	41,9	60	49,5	54,2	30,35	29,00	29,85	81	58	69,9	1,766
Whole year			50.5			58.4			29.87				19.489

END OF VOL. I. PART II.

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⁂ *The* THIRD VOLUME *of the* ASIATIC RESEARCHES *will be continued in* PART II.

MEMOIRS
OF
SCIENCE AND THE ARTS.
VOL II. PART I.

Commentaries of the Royal Society of Sciences at Gottingen, for the Years 1791, 1792. *Vol.* XI.

PHYSICAL CLASS.

I. *Commentary on the Circonian Stone, on the Mixture of Lead with Copper, and on the Cactus Peruvianus. By* Jo. Fred. Gmelin.

1. ON *the Circonian Stone.* This gem, hitherto found only in the iſle of Ceylon, had undergone the examination of Meſſrs. Wiegleb and Klaproth. Mr. Gmelin has alſo ſubmitted it to chymical inveſtigation, the reſult of which he here relates. The ſtones which he employed were greeniſh, yellowiſh, reddiſh and browniſh, and all rounded. Their ſpecific gravity was 4304, which is ſomewhat leſs than others have ſtated, but is ſtill more than that of almoſt all other unmetallic ſtones, heavy ſpar excepted. He began his treatment, as the other two experimenters had done, by calcining the ſtones in a white heat, then throwing them into cold water, and afterwards reducing them to fine powder; but he differed from them in not joining lixivial ſalts to them in the calcination, and in trying the effects of the vitriolic and nitrous acids upon them, as well as the marine. The concluſions drawn from his experiments, are the following: that the vitriolic and nitrous acids have more effect in diſſolving this ſtone and extracting the particles acted on by acids, than the marine; and that it contains leſs ſiliceous earth inſoluble in acids than Wiegleb's analyſis ſhowed: that he could not diſcover the leaſt veſtige of that bitter earth which Wiegleb mentions: that neither did his experiments detect any marks of that metallic earth of nickel which Klaproth found united to the calx of iron: that he could ſee ſcarcely the ſlighteſt traces of aluminous and calcareous earth: that ſome experiments gave a ſuſpicion of the exiſtence of a little manganeſe: that he obtained much calx of iron; and alſo a ſingular earth, much reſembling that of alum, but clearly differing from it, by its inſolubility in cauſtic alkali, and its producing with vitriolic acid a ſalt very readily diſſolving in water.

2. *On the union of Lead with Copper.* Theſe two metals have been united in dif-

ferent proportions for a variety of purpoſes, both with and without the mixture of other metals. But Mr. Achard, in a great number of experiments for uniting copper with iron and lead in various ways, was able to obtain only a brittle metal, generally porous, and ſeldom equable. Mr. Gmelin made the following experiments on the ſimple union of lead and copper.

Exp. 1. Two parts of copper filings wrapt in one of ſheet lead were melted in an earthen crucible, the inſide of which was firſt coated with powder of charcoal, and the whole then filled with the ſame powder. The cooled maſs was for the moſt part equable, bore the hammer, and was eaſily filed. Its colour was paler than that of copper. Specific gravity 8,530. *Exp.* 2. Equal parts of the two metals ſimilarly combined, gave an equable maſs, capable of being beaten into thin leaves, but leſs eaſily filed than pure lead. It took an excellent poliſh. The colour was mixed. *Exp.* 3. Two parts of lead and one of copper yielded a leſs equable and more brittle maſs, eaſily filed, and of a colour neareſt to lead. Specific gravity, 9,950. *Exp.* 4. Three parts of lead with one of copper mixed unequably; the maſs was ſoft and flexible, of a leaden colour, tarniſhing in the air. *Exp.* 5. Four of lead to one of copper. The maſs equable, and in colour, ſoftneſs and ductility, approaching to lead. Specific gravity, 10,550. *Exp.* 6. Six of lead to one of copper. Scarcely diſtinguiſhable from lead. *Exp.* 7. Twelve of lead to one of copper. A very equable maſs, reſembling lead, but ſomewhat harder. Specific gravity, 10,420. The concluſions from the whole are, that various mixtures of lead and copper may be obtained without much loſs of ductility, but with leſs improvement to the lead in ſplendour, colour, durability and hardneſs, than might have been expected.

3. *On the Cactus Peruvianus.* This ſpecies of Cactus ſo ſeldom flowers in the climate of Gottingen, that Prof. Murray never once ſaw it in flower while he ſuperintended the royal garden, and moſt of the figures of it in authors are without flowers. That of Plumier, publiſhed by Burmann (in *Plant. Amer. faſc.* 1. t. 191) though it gives the flower, is neither ſhaded nor coloured. Mr. Gmelin has therefore been induced to offer exact figures of it, with a deſcription. The ſpecies is the cactus (peruvianus) longus ſuboctangularis: angulis obtuſis. *Linn. Syſt. Nat. edit.* 13. It grows ſpontaneouſly in all the ſouthern parts of America, as in Chili and the iſlands off its coaſt, in Hiſpaniola, Jamaica, and all the Antilles. The colour of the flower, which conſiſts of about 20 lanceolate petals united at the baſe, is reddiſh towards the point and margin of the petals, and pale green elſewhere.

II. *Experiments reſpecting the Union of Manganeſe with Lead, Antimony and Arſenic; alſo an Analyſis made the moiſt way of the Lauterberg Iron Ore.* By Jo. Fred. Gmelin.

IN attempting to procure an union between lead and manganeſe, Mr. Gmelin mixed the latter, reduced to fine powder, with an equal weight of powdered charcoal, and as much rape oil as would make them lie in a hollow form at the bottom of a crucible. The fire was then gradually raiſed, and as ſoon as the oil ceaſed to emit ſmoak, the lead was thrown in, the reſt of the crucible filled with pounded coals, and a very ſtrong heat was applied for about three quarters of an hour. Various proportions of the two, from 15 grains of manganeſe and half an ounce of lead, to an ounce of the former and two drachms of the latter, were tried in this manner in a ſeries of experiments. In moſt of them the lead had acquired ſome increaſe of weight, and appeared from teſts to have imbibed a very ſmall portion of the manganeſe, but with no ſenſible change of its general properties. Experiments made upon a ſimilar plan with various proportions of regulus of antimony and manganeſe, were ineffectual in procuring a combination between them. Nor could any metallic globules be produced from manganeſe when treated in any manner and proportion with arſenic.

With reſpect to the Lauterberg iron ore, it is a ſpecies of red hematite, very rich in metal, but of a notorious bad quality. Mr. Gmelin's analyſis was inſtituted for the purpoſe of detecting the ingredient which thus injured the iron. For this purpoſe, he diſſolved two drachms of the ore in ſucceſſively applied quantities of marine and nitrous acid, only ſeven grains at laſt remaining undiſſolved. The mixed ſolutions were precipitated with phlogiſticated and common alkali, and the precipitates examined by various teſts. The reſult is, that this ore ſeems to contain calx of iron with a ſmall quantity of phoſphoric acid, and a portion of manganeſe and of earth of alum. He ſuppoſes that the injury the iron receives from theſe admixtures might be corrected by adding a large quantity of calcareous earth to it in the furnace.

III. *An Attempt to relieve Defects of Hearing.* By LEBRECHT FRED. BENJ. LENTIN.

THE principal purpoſe of this writer is, from the diſcoveries of anatomiſts reſpecting the ſtructure of the internal ear, to ſuggeſt new methods of relieving defects in the ſenſe of hearing. He begins with adverting to thoſe branches of abſorbents which take up the acuſtic water from its receptacles, ſome of which diſcharge it through the ſmall holes of the occipital bone, others into the lateral ſinuſſes and jugular vein. In ſome caſes of deafneſs not to be attributed to other cauſes, he has given relief by ſtimulant applications or ulcerations on the occiput, firſt ſhaved. Ulcerations here are alſo of great uſe in that acute pain of the face deſcribed firſt by Fothergill, the cauſe of which he ſuppoſes to exiſt in the hard nerve and its ultimate ramifications. He has relieved, and at length cured, it by a mixture of opium and tinct. of aſafœtida conveyed to the bottom of the ear. The common ear-ach of children is a totally different complaint, and owing to ſpaſm. He has cured it by the juice of rue put into the ears.

Another cauſe of deafneſs may be an alteration in the quantity or quality of the water filling the whole cavity of the labyrinth, and ſerving for the propagation of ſonorous waves to the auditory nerve. This may become thick, turbid, or corroſive, and thus injure the hearing. The application of leeches near the maſtoid proceſs and on the occiput, and ſucceeding mercurial friction to thoſe parts, are likely means for relief.

The uſe of the euſtachian tubes in aſſiſting the hearing is well known, as likewiſe that their obſtruction will injure that ſenſe. The writer propoſes an inſtrument, which a bent ſilver probe ending in a little plate on which a piece of ſpunge is faſtened, for the purpoſe of applying any deterſive liquors to the orifices of theſe tubes, and thus preparing the way for injections into them.

The defects of hearing from *conſent*, almoſt all ariſe from crudities in the inteſtinal canal, and are to be remedied by emetic and cathartic medicines. Others are *metaſtatical* in their origin, in which caſe regard is to be had to the primary diſeaſe. Congeſtions in the ears from the ſuppreſſion of periodical or other diſcharges of the humours are further cauſes of deafneſs, and ſometimes become perpetual. The want of due communication of oſcillatory motions through the bones and ſoft parts to the organ of hearing may be another ſource of this defect; at leaſt we know that it is often relieved by exciting ſuch oſcillations. Many obſcure and hitherto incurable diſeaſes of the organ of hearing remain to exerciſe the induſtry and ſagacity of future enquirers.

IV. *The ſecond Decad of Jo. Fred. Blumenbach's Collection of Skulls of different Nations, illuſtrated.*

Three Specimens of Variety 1ſt.

11. *SKULL of a genuine Zingari, or Gipſy.* This tribe of people is found unmixed in Tranſylvania alone. The ſkull is of a famous robber who died in priſon. *Primary characters.* Face oblong. Fore-head ſmall, arched. Superciliary arches very prominent. Orbits very deep. Seat of ſmelling very ample; the middle ſhells on each ſide inflated to large bulbs, and the Santorinian ſinuſſes excavated. Teeth large, eſpecially the grinders. Jaws ſomewhat prominent. *Other obſervations.* Sutures, particularly the occipital, elegantly waving. Occipital hole nearly ſquare: the condyles at its ſide very convex. Palate high roofed: horizontal lamina of the palate bone very large. The reſemblance of this head and ſkull to thoſe of the Egyptian mummy, Dec. 1. tab. 1. was very ſtriking, and ſeems a ſtrong argument of a common origin.

12. *Of a Caſan Tartar.* A young man: the ſkull very elegantly conformed. *Primary charact.* Large forehead, moderately arched: ſuperciliary arches neither protuberant, nor diſtinguiſhed by a depreſſed ſmooth part, but uniting equably: bone of the noſe neither aquiline nor depreſſed, but deſcending in a fair direction: ſemiorbital plane in the temples inſenſibly terminating in the bones of the forehead and vertex: upper row of teeth ſomewhat prominent beyond the under all round: upper inciſors and canine teeth proportionally larger than the reſt, but all the teeth ſymmetrical and contiguous: chin a little prominent; and inferior margin of the lateral alæ of the lower jaw turned ſomewhat outwards. *Other obſerv.* No external occipital protuberance: lambdoidal ſuture diſtinguiſhed by the ſmall bones of Wormius: lower jaw remarkably thick where it contains the ſockets of the grinders. The ſymmetry of this ſkull differs greatly from the modern repreſentations of the Tartar face, which are really taken from a very different race of men, the Mongols or Kalmucs.

13. *Of a Kirgis Coſſack.* An old head. *Primary charact.* Habit a medium between the Tartar and Mongol. Face pretty wide at the cheek bones, the malar ſurface of the maxillary bones being flattened, and without a pit; but the forehead narrower than in the Mongol's, and orbits deeper, and leſs open above. The glabella prominent. The back of the noſe narrower and more prominent than in the Mongols. *Other obſerv.* Horizontal lamina of the palate bones very narrow. Upper, interior and inferior parietes of the orbit very thin, their ſubſtance being probably abſorbed through age, the ſutures being alſo obliterated.

Three Specimens of Variety the ſecond.

14. *Second Calmuc.* *Primary charact.* Form of the ſkull nearly globular. Face

broad and ſunk. Forehead flattened. Cheek bones ſtanding out. Orbits very large and open. Superciliary arches elate. The whole cranium as it were inflated and tumid. *Other obſerv.* Singular ſmoothneſs of the ſkull. Horizontal lamina of the palate bones very large. Maſtoid proceſſes as it were bulbous. Entrance of the lacrymal canal very large. Aperture of the noſtrils narrow, oblique. The difference between this ſkull, and that given by Camper as a Calmuc's, and made the ideal model of the greater part of our globe, even to our antipodes, is very ſtriking. His figure ſo much reſembles that of the negro ſkull, that one might ſuſpect him to have been impoſed upon.

15. *Of a Jacutian. Primary charact.* Form nearly ſquare. Very wide orbits ſeparated by a very large cribriform bone. Glabella tumid. Bones of the noſe pinched and uniting above into a ſharp extremity. Bones of the vertex on each ſide riſing into bunches. *Other obſerv.* This appears to be the ſkull of an old man from the toothleſs jaw and obliterated ſutures, even of the face.

16. *Of a Tunguſian. Primary charact.* Habit perfectly Mongol, with a flat broad face, depreſſed forehead, &c. Very large ſeat of ſmelling. Occiput wonderfully protuberant behind, ſo as that its remoteſt part is nine inches from the inciſors. *Other obſerv.* Lower middle part of the os frontis, immediately adjoining the glabella, depreſſed, like a ſhallow pit. Longitudinal criſta of the os unguis running out into a very ſharp edge. External pterygoid proceſſes expanded into very wide wings.

Three Specimens of Variety the third.

17. *Negro 4th.* 18. *Congo negro, 5th.* 19. *Guinea negreſs.* Theſe ſkulls ſhow in a ſtriking manner that the difference of negroes from each other, is at leaſt as great as that between ſome of them, and Europeans.

Specimen of Variety 4th.

20. *Caribbean woman of St. Vincent's.* The horrid and monſtrous diſtortion of this ſkull could only be the effect of art, viz. a violent and continued preſſure on the forehead and nape of the neck; and confirms all that has been ſaid on the poſſibility of ſuch operations on the head by means of bandages and cuſhions.

MATHEMATICAL CLASS.

V. *On the modern Geographical Uſe of the Polar Star. By* ABRAHAM GOTTHELF KAESTNER.

THE ſtar, now called the polar, had not always, nor will always retain that name. On account of the preceſſion of the equinoxes, according to De la Lande's calculation, the pole of the world, approaching or receding from a certain fixed ſtar, revolves round the pole of the ecliptic in $25791\frac{3}{67}$ years. In the time of Hipparchus it was at a greater diſtance from the extremity of the tail of urſa minor, than from any other point of that conſtellation; and Fournier declares that ancient navigators uſed for a polar ſtar the laſt ſtar but one in the tail of the dragon.*

By the ſtar neareſt the pole, though not without ſome degree of uncertainty, a meridian line may be aſcertained. Gerbert, of Magdeburg, in the conſtruction of his horologium obſerved by means of a tube, the polar ſtar, though from his problem to find a meridian line from three ſhadows of a ſtyle projected on the ſame day, there can be no doubt that he made uſe alſo of an obſervation of the ſun in the meridian. By means of the polar ſtar, De la Lande teaches us to mark out the plane of the meridian, and from thence the ſituation of terreſtrial objects is deſcribed.* From the height of the polar ſtar at any time, its azimuth may be known, and hence the poſition of any object on land compared with this ſtar being given, its azimuth will alſo be known; and on this were founded the obſervations made by Roy for diſcovering the relative ſituations of the obſervatories at Greenwich and Paris.

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* Vorſtellung der Geſtirne. Berlin 1782. Tab. xxxiii. Hydrographie. L. x. c. 26.

It has been the object of this writer to ſtudy the method uſed upon that occaſion, and to find what is the greateſt azimuth of the polar ſtar, and what may be collected from the obſervation of other altitudes. Le Gendre in his memoir on the figure of the earth, has given ſeveral formulæ, but without demonſtrations or examples. In the firſt by an angle whoſe ſides are inclined to the horizon, he finds the correſponding horizontal angle. Others relate to arcs on the ſurface of the earth, and the ſpherical angles contained by them. At the end are the effects of refraction in obſervations of the polar ſtar. As theſe things are very obſcurely treated of by Le Gendre, they are more fully explained in this memoir.

1. Formulas relating to the diurnal motion of a ſtar near to the pole.

Let the height of the pole $= \varepsilon$, ſtar's declination δ, height η, parallactic angle σ, azimuth from northern point α, horary angle τ, & $\varphi = 90^\circ - \delta$.

2) I) $$(\mathrm{ſin}\,\tfrac{1}{2}\tau)^2 = \frac{\mathrm{coſ}\,\frac{\varphi+\varepsilon+\eta}{2}.\ \mathrm{ſin}\,\frac{\varphi+\varepsilon-\eta}{2}}{\mathrm{ſin}\,\varphi.\ \mathrm{coſ}\,\varepsilon}$$

II) $$(\mathrm{ſin}\,\tfrac{1}{2}\alpha)^2 = \frac{\mathrm{ſin}\,\frac{\varphi-\varepsilon+\eta}{2}.\ \mathrm{ſin}\,\frac{\varphi+\varepsilon-\eta}{2}}{\mathrm{coſ}\,\eta.\ \mathrm{coſ}\,\varepsilon}$$

III) $$(\mathrm{ſin}\,\tfrac{1}{2}\sigma)^2 = \frac{\mathrm{ſin}\,\frac{\varphi-\varepsilon+\eta}{2}.\ \mathrm{coſ}\,\frac{\varphi+\varepsilon+\eta}{2}}{\mathrm{coſ}\,\eta.\ \mathrm{ſin}\,\varphi}$$

IV) $$\mathrm{coſ}\,\tau = \frac{\mathrm{ſin}\,\eta - \mathrm{ſin}\,\varepsilon.\ \mathrm{coſ}\,\varphi}{\mathrm{coſ}\,\varepsilon.\ \mathrm{ſin}\,\varphi}$$

V) $$\mathrm{coſ}\,\alpha = \frac{\mathrm{coſ}\,\varphi - \mathrm{ſin}\,\varepsilon.\ \mathrm{ſin}\,\eta}{\mathrm{coſ}\,\eta.\ \mathrm{coſ}\,\varepsilon}$$

VI) $$\mathrm{coſ}\,\sigma = \frac{\mathrm{ſin}\,\varepsilon - \mathrm{coſ}\,\varphi.\ \mathrm{ſin}\,\eta}{\mathrm{ſin}\,\varphi.\ \mathrm{coſ}\,\eta}$$

When the azimuth is the greateſt, the parallactic angle is a right angle, and the ſine of the altitude $= \frac{\mathrm{ſin}\,\varepsilon}{\mathrm{coſ}\,\varphi}$. Let the altitude at this point $=$ H. the greateſt azimuth A and the horary angle $=$ T. (See Plate I. Fig. 1.) Sin. A $= \frac{\mathrm{ſin}\,\varphi}{\mathrm{coſ}\,\varepsilon}$. In form. IV.

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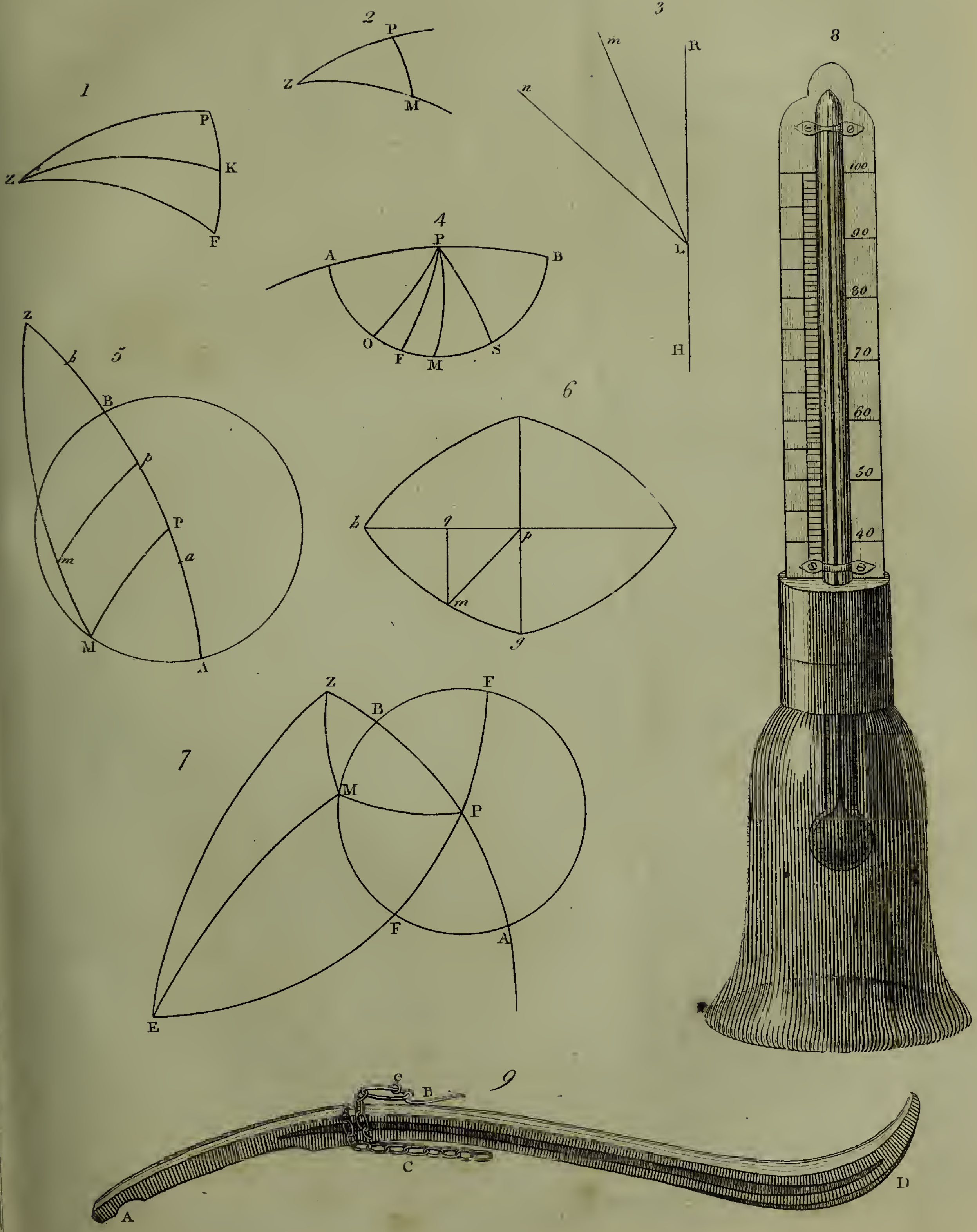
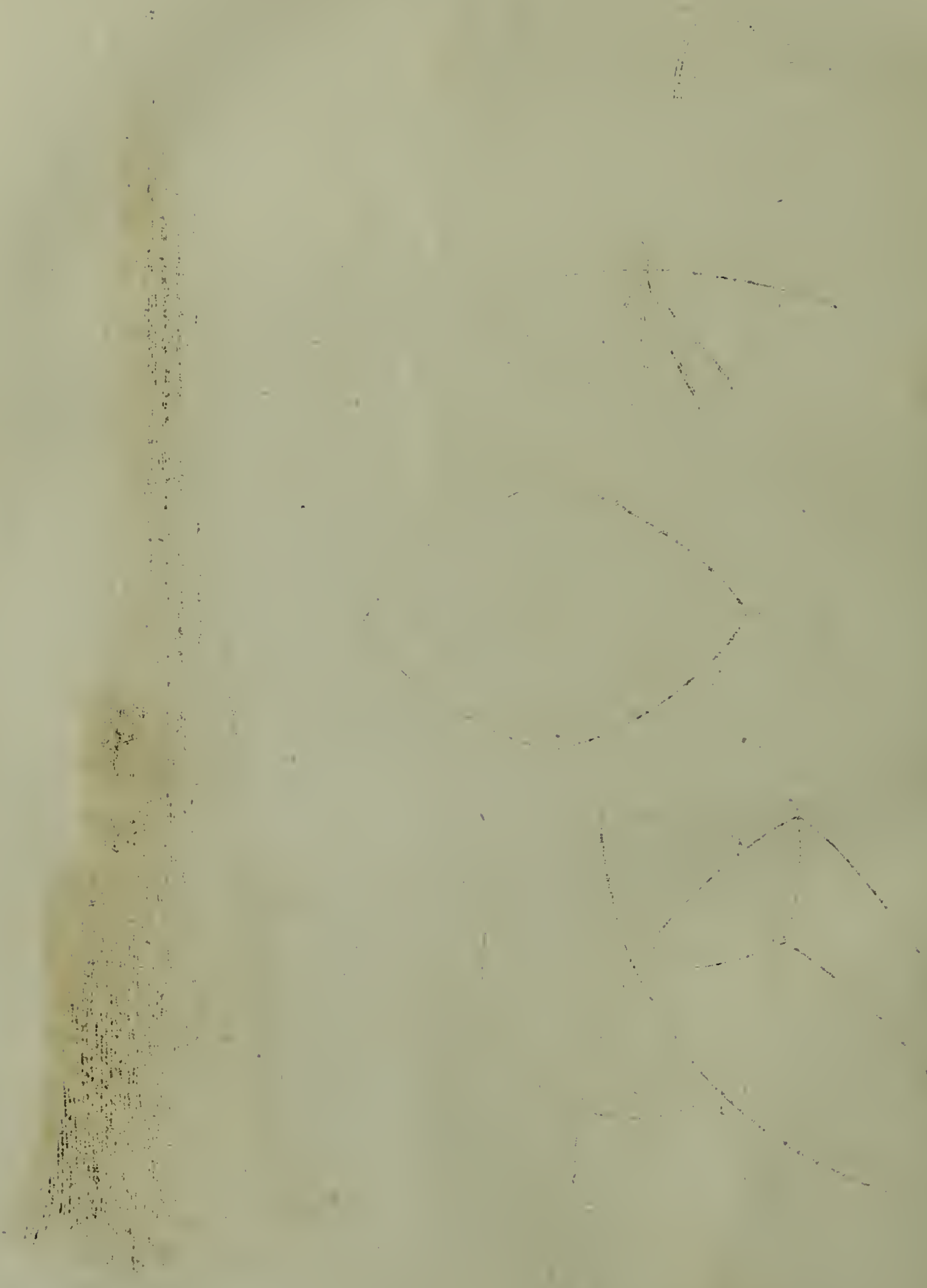
* Dilmari Merogburgenſis Chron. Lib. vi. 399. ed. Leib. 1707 Fol. Geometriſche abhandlungen 1. Samml. Goett. 1790. Fr. a Schooten. Ex. Math. Libr. v. Sect. 28. Lergd.Bal. 1657.

Facing p. 9.

Plate. I.





IV. $\frac{\text{ſin } 2}{\text{coſ } \varphi} - \text{ſin } \varepsilon + \text{coſ } \varphi = \frac{\text{ſin } \varepsilon . (\text{ſin } \varphi)^2}{\text{coſ } \varphi}$ ∴ $\text{coſ T} = \text{tang } \varepsilon . \text{ tang } \varphi .$

Sin H. $\text{ſin A} = \text{coſ T}$ ∴ $\text{ſin H} = \frac{\text{coſ T}}{\text{ſin A}}.$

As the ſines and tangents of ſmall arcs are found with great eaſe than their coſines; obtain firſt the values of A and T, from whence H may be had and $\text{coſ } \varphi = \frac{\text{ſin } \varepsilon}{\text{ſin H}}.$

Alſo $\text{ſin T} = \frac{\text{coſ H}}{\text{coſ } \varepsilon}$

When the hour angle is a right angle.

In the triangle ZPM. (See Plate I. Fig. 2) coſ ZM = coſ ZP. coſ PM ∴ ſin Alt = $\text{ſin } \varepsilon . \text{ coſ } \varphi .$ for the azimuth $\text{tang PZM} = \frac{\varphi}{\text{coſ } \varepsilon}.$ tang parallactic angle $= \frac{\text{cot } \varepsilon}{\text{ſin } \varphi}.$ and $\text{ſin alt.} = \frac{\text{tang } \varepsilon . \text{ ſin } \varphi}{\text{tang PZM}}.$

When the altitude is equal to the elevation of the pole.

Then (Fig. 1) ZP = ZI = $90^\circ - \varepsilon$, PI = φ which being biſected by the perpendicular ZK, $\text{coſ ZK} = \frac{\text{ſin } \varepsilon}{\text{coſ } \frac{1}{2} \varphi}$ and ſine of ½ the azimuth $= \text{ſin} \frac{\frac{1}{2} \varphi}{\text{coſ } \varepsilon}$ and for the hour angle $\text{coſ ZPI} = \text{tang } \varepsilon . \text{ tang. } \frac{1}{2} \varphi .$

Hence to define the poſition of terreſtrial objects.

Let L (See Plate I. Fig. 3.) be the place of obſervation, HLR its meridian not known. The height of the polar ſtar being obſerved, the ſection which the vertical plane, in which the ſtar is, makes with the horizon L*m* is given, and the azimuth being calculated from the altitude, the angle *m*LR, and conſequently the poſition of the meridian line are given.

Let the vertical plane in which ſome terreſtrial object is ſituated, cut the horizon in L*n*, ∴ the angles *n*L*m* and *n*LR the azimuth of the object are given. It is beſt for obvious reaſons to take the height of the polar ſtar, when its azimuth is the greateſt.

On the diſtance of the polar ſtar from the pole.

According to Vince on the firſt of January, 1787, it was 1°..49′..8″,8; the effect of the annual præceſſion of the equinox, in declination 19″,55. De la Lande makes the ſecular præceſſion 1°..23′..45″, the error to be ſuppoſed in ſuch a calculation not exceeding 5″, and hence the annual præceſſion is 50″,25, allowing a probable error of 0″,05. From theſe data formulas may be conſtructed for the change of a ſtar's place in a right aſcenſion and declination by well known rules. By the calculation of De Lambre* in the beginning of the year 1792, the polar ſtar was in 12°..37′..56″ r. aſc ann. var. 18″,6. Decl. 88°..11′..48″, ann. var. 19″,6. Hence it appears that for the preſent age, Vince's calculation is accurate, but for ſomewhat more than three centuries the pole will approach to the polar ſtar to within 27′..19″, then by continual receding from it, the ſtar will be no longer polar.

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* Connoiſſance des temps. 1792.

There are theſe inconveniences attending the polar ſtar, that from its declination and longitude approaching nearly to a quadrant, they cannot be ſo eaſily marked in whole numbers. The Bernouilli's have ſhewn their uſual induſtry and ſagacity on this ſubject.

De la Caille gives for the beginning of the year 1750 for the polar ſtar 10°..40′..56″ r. aſc. 87°..58′..2,4″ decl. 85°..4′..12″ long. 66°..4′..21″ lat. The Bernouilli's with the beſt trigonometrical tables extant, with all their labour could not bring theſe numbers to an exact agreement, and as the coſines of ſmall arcs muſt be uſed, whoſe logarithms are not ſufficiently diſtinguiſhed, this will not appear extraordinary. From the expreſſion $\text{coſ} = \dfrac{\text{ſine}}{\text{tang}}$, if the ſines and tangents of ſmall arcs were accurately given, the coſine might be found, but the logarithms not having in general more than ſeven decimal figures, the coſines will not eaſily be diſtinguiſhed.

Example of the mode of calculating.

In the Connoiſſance des Temps for the beginning of the year 1791, the right aſc is made = 50 M time. decl. = 88°..11′..28″ ∴ φ = 1°..48′..32″ and $\frac{1}{2}\varphi$ = 54′..16″. At Gottingen ε = 51°..31′..54″ ∴ compl. = 38°..28′..6″, and greateſt alt. of the ſtar = $\varepsilon + \varphi$ = 53°..20′..26″ leaſt = $\varepsilon - \varphi$ = 49°..43′..22″.

For the greateſt azimuth.

$$\begin{array}{rl}
\text{log ſin } \varphi = & 18{,}4992171 \\
\text{log coſ } \varepsilon = & 9{,}7938476 \\
\hline
\text{log ſin A} = & 5{,}7053698 \\
\hline
\text{log tang } \varepsilon = & 10{,}0998875 \\
\text{log tang } \varphi = & 8{,}4994336 \\
\hline
\text{log coſ T} = & 8{,}5993211 \\
\hline
\text{log coſ T} = & 18{,}5993211 \\
\text{log ſin A} = & 8{,}7053695 \\
\hline
\text{log ſin H} = & 9{,}8939516 \\
\text{log ſin } \varepsilon = & 19{,}8937352 \\
\hline
\text{log coſ } \varphi = & 9{,}9997836
\end{array}$$

Hence A = 2°..54′..30″. T = 87°..43′..20″. H = 51°..34′..3″, and the greateſt azimuth is at 5*h*..20′..53″..20‴ before or after the paſſage over the meridian.

For the azimuth for any given height.

$$\begin{array}{rl}
\eta = & 51^{\circ} \\
\varepsilon - \varphi = & 49\ \ 43\ \ 22 \\
\hline
\varphi - \varepsilon + \eta = & 1\ \ 16\ \ 38 \\
\frac{1}{2} = & 0\ \ 38\ \ 19 \\
\varepsilon + \varphi = & 53\ \ 20\ \ 26 \\
\varphi + \varepsilon - \eta = & 2\ \ 20\ \ 26 \\
\frac{1}{2} = & 1\ \ 10\ \ 13 \\
\text{log ſin } \frac{1}{2}(\varphi - \varepsilon + \eta) = & 8{,}0471048 \\
\text{log ſin } \frac{1}{2}(\varphi + \varepsilon - \eta) = & 8{,}3101361 \\
\hline
 & 16{,}3572409
\end{array}$$

$$\begin{array}{rr} \log \text{coſ}\, \varepsilon = & 9{,}7938976 \\ \log \text{coſ}\, \eta = & 9{,}7988718 \\ \hline & 19{,}5927694 \\ a = & 36{,}3572409 \\ \hline & 16{,}7644715 \\ \tfrac{1}{2} = & 8{,}3822357 \\ \tfrac{1}{2}\alpha = & 1^{\circ}\ 22'\ 54''\text{—} \\ \alpha = & 2\ \ 45\ \ 48 \end{array}$$

The increment of altitude, being 34′..3″ the correſponding increment of azimuth is 8′..42″.

In the ſame manner the hour angle is found when a right one, and the time when the height of the ſtar is equal to that of the pole.

Demonſtration of le Gendre's Formulas.

P the true pole whoſe alt = L, diſtance from zenith ZP = 90°—L, ſtars diſtance from P = PA = PM = PB = a, hour angle APM = t, diſtance from zenith ZM = v, greateſt diſtance from zenith ZA = 90° — L+A, leaſt diſtance ZB = 90 — L — a. By Euler's forms as given in II. Aſtr. Abh. II C. §. 88.

$$\begin{array}{c|c|c|c|c|c} a & A & b & c & B & C \\ v & 180^{\circ}-t & 90^{\circ}-L & a & M & Z \end{array}$$

$$\therefore\ \text{coſ.}\ v = -\ \text{coſ.}\ t.\ \text{coſ.}\ L.\ \text{ſin}\ a + \text{ſin}\ L.\ \text{coſ.}\ a$$

$$\text{tang}\ M = \frac{\text{ſin}\ t.\ \text{cot.}\ L}{\text{ſin}\ a + \text{cot.}\ L.\ \text{coſ.}\ a.\ \text{coſ.}\ t}$$

$$\text{tang}\ Z = \frac{\text{ſin}\ t.\ \text{tang}\ a}{\text{coſ.}\ L + \text{tang}\ a.\ \text{ſin}\ L.\ \text{coſ.}\ t}$$

and ſince $\text{coſ}\ t = 1 - 2.\ \overline{\text{ſin}\ \tfrac{1}{2} t}|^{2};\ \text{coſ}\ v = \text{ſin.}\ \overline{L - a} + 2.\ \overline{\text{ſin}\ \tfrac{1}{2} t.}|^{2}\ \text{coſ}\, L.\ \text{ſin}\ a.$

from III. Aſtr. Abh. 9.

$$\text{coſ.}\ Z = \frac{\text{coſ.}\ a - \text{ſin}\ L.\ \text{coſ}\ v.}{\text{ſin}\ v.\ \text{coſ.}\ L}\ \text{and coſ.}\ M = \frac{\text{ſin}\ L - \text{coſ.}\ a.\ \text{coſ}\ v}{\text{ſin}\ a.\ \text{ſin}\ v}$$

$$= \frac{\text{ſin}\ L.\ \text{ſin}\ a + \text{coſ.}\ t.\ \text{coſ.}\ L.\ \text{coſ.}\ a}{\text{ſin}\ v.}$$

$$\text{and ſin}\ M = \frac{\text{ſin}\ t.\ \text{coſ.}\ L}{\text{ſin}\ v.}$$

$$\overline{\text{ſin}\ v}|^{2} = \overline{\text{coſ.}\ L - a}|^{2} - 4.\ \text{ſin}\ \overline{L - a}.\ \overline{\text{ſin}\ \tfrac{1}{2} t.}|^{2}\ \text{coſ.}\ L.\ \text{ſin}\ a$$
$$-\ 4.\ \overline{\text{ſin}\ \tfrac{1}{2} t.}|^{4}\ \overline{\text{coſ.}\ L.\ \text{ſin}\ a}|^{2}$$

Hence by extracting the root we have the ſine, which being divided by the coſine gives the tangent.

If a is very ſmall compared with L the laſt term may be neglected and $\text{ſin}\ v = \text{coſ.}\ \overline{L - a} - 2\ \text{tang}\ \overline{L - a}.\ \overline{\text{ſin}\ \tfrac{1}{2} t.}|^{2}\ \text{coſ.}\ L.\ \text{ſin}\ a$ and

$$\text{tang}\ v = \frac{\text{coſ.}\ \overline{L - a} - 2.\ \text{tang}\ \overline{L - a}.\ \overline{\text{ſin}\ \tfrac{1}{2} t.}|^{2}\ \text{coſ.}\ L.\ \text{ſin}\ a}{\text{ſin}\ \overline{L - a} + 2.\ \overline{\text{ſin}\ \tfrac{1}{2} t)}.^{2}\ \text{coſ.}\ L.\ \text{ſin}\ a.}$$

On the Effect of Refraction.

The refractions in the greater altitudes vary as the tangents of the zenith diſtances. Let w be the refraction when the true height is equal to the elevation of the pole. $\therefore$ cot. L : tang v : : w : Mm refraction at diſtance $v =$ tang L. tang v. w. Let p. a. b. be the apparent places of the ſtar at P. A. B. (Fig. 4.)

Then $\text{A}a = \text{tang. ZA. tang. L.}\, w = \frac{1 + \text{tang. L. tang.}\, a}{1 - \text{cot. L. tang.}\, a} w$

$\text{B}b = \text{tang. ZB. tang. L.}\, w = \frac{1 - \text{tang. L.}\, a}{1 + \text{cot. L. tang.}\, a}$

$\text{A}a - w = \frac{\overline{\text{tang L} + \text{cot. L.}}\ \text{tang.}\, a.\, w}{1 - \text{cot L. tang.}\, a}$

$= \frac{\text{tang}\, a.\, w}{\text{ſin L. coſ. L.}\ \overline{1 - \text{cot. L. tang.}\, a}}$

$w - \text{B}b = \frac{\text{tang}\, a.\, w.}{\text{ſin L. coſ. L.}\ \overline{1 + \text{cot. L. tang.}\, a}}$

Take the ſmall arcs inſtead of the tangents, and there will be had the differences $= \frac{a.\, w}{\text{ſin L. coſ. L}}$

$\therefore pa = a - \text{A}\, a + w;\ pb = a - w + \text{B}b$ each $= a\ \frac{-2\, a\, w}{\text{ſin. 2. L.}}$

To find the quantities pm, Ppm (Fig. 5,) MPpm is ſuppoſed a rectilinear plain, in which are given PM $= a$; Mm, Pp, M, MP$p = 180 - t$.

$\text{P}m^2 = a^2 - 2\, a.\ \text{M}m.\ \text{coſ. M} + \text{M}m^2$ but Mm being very ſmall compared with a, $\text{P}m = a - \text{M}m.\ \text{coſ. M}$. M becoming nearly a right angle, the ſecond term on the right hand ſide would be leſs than the third, or this term vaniſhing, Pm would $= a$; $\frac{w^2}{2a}$ being neglected.

$\therefore \text{P}m = a - \text{tang L. tang.}\, v.\ \frac{\overline{\text{ſin L. ſin.}\, a + \text{coſ.}\, t.\ \text{coſ. L. coſ.}\, a.\, w}}{\text{ſin}\, v.}$

In the part which is ſubtracted, that which is multiplied into w is tang L. $\frac{\text{ſin L. ſin}\, a + \text{coſ}\, t.\ \text{coſ. L. coſ}\, a}{\text{ſin L. coſ}\, a - \text{coſ}\, t.\ \text{coſ. L. ſin}\, a}$

Divide the numerator and denominator by ſin L. coſ a. it becomes $\frac{\text{tang L. tang}\, a + \text{coſ}\, t}{1 - \text{coſ}\, t.\ \text{cot L. ſin}\, a}$. Aſſuming the arc inſtead of the tangent and ſine, and neglecting the ſquare of this ſmall arc $\frac{1}{1 - \text{coſ}\, t.\ \text{cot L. ſin}\, a} = 1 + \text{coſ}\, t.\ \text{cot L.}\, a$ nearly which being multiplied into the numerator gives $\overline{\text{tang. L} + \overline{\text{coſ}\, t.)}^2\ \text{cot L.}\, a + \text{coſ}\, t}$

That which is multiplied into a is $\text{tang L} + \text{cot L} - \overline{\text{ſin}\, t.)}^2\ \text{cot L.} = \frac{2}{\text{ſin 2 L.}} - \overline{\text{ſin}\, t.)}^2$ cot L and becomes $\frac{2}{\text{ſin 2 L.}} - \overline{\text{ſin}\, t.)}^2\ \text{cot L.}\, a + \text{coſ.}\, t$

Pm

$$Pm = a - \left(\frac{2}{\text{ſin } 2\,\text{L}} - \overline{\text{ſin } t.}^2 \ \text{cot L.}\right) a.\, w - \text{coſ } t.\, w$$

$$= a.\left(1 - \left(\frac{2}{\text{ſin } 2\,\text{L}} - \text{ſin } t.^2 \ \text{cot L.}\right) w - \text{coſ. } t.\, \frac{w}{a}\right)$$

Whence $\frac{1}{Pm} = \frac{1}{a}\left(1 + \left(\frac{2}{\text{ſin } 2\,\text{L}} - \overline{\text{ſin } t.}^2 \ \text{cot L.}\right) w + \text{coſ. } t.\, \frac{w}{a}\right)$

Sin $mPM = \frac{Mm.\ \text{ſin M}}{Pm} \cdot \frac{\text{Sin L. ſin } t}{\text{coſ } v}$ w is to be divided. This is multiplied into that part of the value found which does not contain w, ſince the ſquare of this quantity is neglected. Whence ſin $mPM = \frac{\text{ſin L. ſin } t.\ w}{\text{coſ. } v.\ a}$; Coſ $v. = \text{ſin L.} - \text{coſ } t.\ \text{coſ L.}\ a = \text{ſin L.}\ (1 - \text{coſ } t.\ \text{cot L.}\ a)$ whence $\frac{1}{\text{coſ } v} = \frac{1}{\text{ſin L}}(1 + \text{coſ. } t.\ \text{cot L.}\ a)$ $\therefore$ ſin $mPM = \frac{\text{ſin } t.\ w}{a} + \text{ſin t. coſ. } t.\ \text{cot L.}\ w.$ mPM is always ſo ſmall that it may be ſubſtituted for its ſine and its coſine be made = 1.

Coſ. mPp = coſ. MPp. coſ. MPm + ſin MPp. ſin MPm which becomes $- \text{coſ } t + \overline{\text{ſin } t.}^2\ (1 + \text{coſ } t.\ \text{cot L.}\ a)\frac{w}{a}$; $pm^2 = Pm^2 + Pp^2 - 2\, Pm.\ Pp.\ \text{coſ.}\, pPm.$ Whence neglecting Pp^2 $pm = Pm - Pp.$ coſ. pPM, and by neglecting the ſquare of $w = a - \frac{2\, a.\ w}{\text{ſin. } 2\,\text{L}} + \overline{\text{ſin } t.}^2 \text{ cot L.}\ a.\ w. - \text{coſ } t.\ w. + \text{coſ. } t.\ w.$ $\therefore pm = a - \frac{2a.\ w}{\text{ſin. 2. L}} + \overline{\text{ſin } t.}^2 \text{ cot. L.}\ a.\ w.$ or $a\,(1 + \text{R.}\ w.)$ Let $t = 0$ or 180° $pm = a - \frac{2\ a\ w}{\text{ſin. } 2\,\text{L}} = pb$ if $t = 90°$ or 270°, $pm = a - \frac{2.\ a.\ w}{\text{ſin } 2\,\text{L}} + \text{cot L.}\ a.\ w = a - \text{tang L.}\ a.\ w.$

For the difference between mpP and t draw pS parallel to PM. $PpS = t$, $PSp = mPM \therefore mSp = 180° - MPm \therefore$ difference is $mpS = x$ and ſin $x = \frac{mS}{pm}.$ ſin MPm.

$$\text{Sin. } PSp : \text{Sin. } Pps. :: Pp : PS$$
$$\text{Sin. } MPm : \text{Sin. } t :: w : PS$$

$$\therefore Pm - PS = mS = \frac{Pm.\ \text{ſin. } MPm - w.\ \text{ſin } t}{\text{ſin. } MPm.}$$

Sin. mPM multiplied into that part of Pm which does not contain w gives ſin $t.\ w$ + ſin $t.$ coſ $t.$ cot L. $a.\ w$ and ſin $x = \frac{\text{ſin } t.\ \text{coſ } t.\ \text{cot L.}\ a.\ w}{pm}$; $\frac{1}{pm} = \frac{1}{a}.(1 - \text{R}\, w)$ $\therefore$ neglecting the uſual quantities in this calculation, ſin x = ſin $t.$ coſ $t.$ cot L. $w.$ and as it may be taken for the angle, $Ppm = t + \frac{1}{2}\ \text{ſin}\ (2.\ t.)\ \text{cot L}\ w.$

The polar ſtar has from refraction an apparent diurnal motion in an ellipſe.

(See Fig. 6.) Let m be a point in an ellipſe, whoſe center is p. pb. the ſemiaxis major $= f$, pg ſemiaxis vertical $= g$, $apm = n$, $pm = z$ to find the relation between pm and avm.

Draw the perpendicular mq, then $pq = z\ \text{ſin}\ \eta$, and $mq = z.\ \text{coſ}\ \eta.\ \therefore z^2.\ \overline{\text{coſ.}\ \eta}|^2 = g^2 - \frac{g^2}{f^2}.\ z.^2\ \overline{\text{ſin}\ \eta}|^2\ \therefore z^2 \left(\overline{\text{coſ.}\ \eta}|^2 + \frac{g^2.}{f^2}\ \overline{\text{ſin}\ \eta}|^2\right) = g^2 \therefore z^2 (f^2 - (f^2.\ g^2).\ \overline{\text{ſin}\ \eta}|^2 = f^2\ g^2\ \therefore z^2 = \dfrac{g^2}{1 - \dfrac{f^2 - g^2}{f^2}.\ (\overline{\text{ſin}\ \eta}|^2}$

Now let $\frac{f^2 - g^2}{f^2}$ be ſo ſmall a quantity that its ſquare might be neglected..

Then $z^2 = g.^2\left(1 + \frac{f^2 - g^2}{f^2}.\ \overline{\text{ſin}\ \eta}|^2\right)$ and $z = g.\left(1 + \frac{f^2 - g_2}{2\ f^2}.\ (\overline{\text{ſin}\ \eta})^2\right)$

Now let $f = a -$ tang $\text{L}.\ a..w.$ and $g = a - \frac{a.\ w.}{\text{ſin L. coſ L}}$ and $\eta = t + \text{ſin}\ t.\ \text{coſ.}\ t.\ \text{cot. L.}\ w.\ \therefore w.^2$ being neglected $f^2 = a^2 - \frac{2\ a.^2\ \text{ſin. L}}{\text{coſ. L}} w.\ g^2 = a^2 - \frac{2a.^2\ w}{\text{ſin L. coſ. L}}\ f^2 - g^2 = 2a^2.\ w.\ \text{cot L}$ and $\frac{f^2 - g^2}{f^2}.\ \overline{\text{ſin}\ t}|^2 = 2.\ w.\ \text{cot. L.}\ \overline{\text{ſin}\ t}|^2$

$\therefore z = a - \frac{a.\ w.}{\text{ſin. L.. coſ. L}} + 2.\ a..w.\ \text{cot. L.}\ \overline{\text{ſin}\ t.}|^2.$

For a terreſtrial Object.

Let M be the true place of the polar ſtar, EM the arc between it and the given object, whoſe zenith diſtance ZE $= \beta$. The time being given, APM and ZM $= v$ are given. In the triangle ZME, the ſides being given, the angle EZM is given as alſo is the azimuth of the ſtar from ZP, PM, and ZPM. and $\therefore$ EZP the azimuth of the object is given. Let PE the diſtance of the object from the pole $= \lambda$, if M is near to F, the ſide PE will be very little leſs than the ſum of the ſides EM, PM. Let EPA $= \gamma$, $\therefore$ MPE $= t - \gamma$.

From MPE, PM, PE to find EM. By III. Aſtr. Abh. Cap. I. 89.

$$\begin{array}{r|c|c|c} a & \text{A} & b & c \\ \text{EM} & \tau - \gamma & a & \lambda \end{array}$$

$\text{coſ. EM} = \text{coſ.}(\tau - \gamma).\ \text{ſin}\ a.\ \text{ſin.}\ \lambda + \text{coſ.}\ a\ \text{coſ.}\ \lambda = \text{coſ.}\ (\lambda - \alpha) - 2.\left(\text{ſin}\frac{t - \gamma}{2}\right).^2\ \text{ſin}\ \lambda.\ \text{ſin.}\ a.$

$\therefore \overline{\text{ſin EM}}|^2 = \text{ſin}\ (\lambda - \alpha)_2 + 4\ \text{coſ.}\ (\lambda - \alpha).\left(\text{ſin}\ \frac{t - \gamma}{2}\right)^2.\ \text{ſin}\ \lambda.\ \text{ſin}\ a - 4\left(\text{ſin}\ \frac{t - \gamma}{2}\right)^4.\ (\text{ſin}\ \lambda.\ \text{ſin}\ a)_2$ neglecting the laſt term. $\text{ſin EM} = \text{ſin}\ (\lambda - \alpha) + \frac{2\ \text{coſ.}\ (\lambda - \alpha)}{\text{ſin}\ (\lambda - \alpha)}.\left(\text{ſin}\ \frac{t - \gamma}{2}\right)^2.\ \text{ſin}\ \lambda.\ \text{ſin}\ a.$

Hence $\text{ſin.}\left(\text{EM} - (\lambda - \alpha)\right) = \dfrac{\left(\text{ſin}\ \frac{t - \gamma}{2}\right)^2}{\text{ſin}\ (\lambda - \alpha)}.\ 2.\ \text{ſin}\ \lambda.\ \text{ſin.}\ a$ the arc having this ſine being taken away from EM, leaves EF the leaſt diſtance of the object from the ſtar.

VI. *An*

VI. *An Occultation of Aldebaran by the Moon, obſerved by* Jo. Hier. Schroeter, *at Lilienthal, November* 1, 1792.

THE obſervation was made with a ſeven foot Herſchellian teleſcope with powers 74, 95, 161. When the ſtar was 30″ from the eaſtern limb of the moon, its light was as uſual, and ſuffered no decreaſe in approaching the limb itſelf. At that time a ſimilar phænomenon ſtruck the writer, to that obſerved by Kaeſtner, in 1752, at Leipſick, in an occultation of Venus, and related in his Elem. Aſtron. § 190. The ſtar did not vaniſh immediately, but ſeemed to paſs before the limb of the moon, being clearly ſeen for two or three ſeconds on its diſc. Then without diminution of light or diameter, it ſuddenly diſappeared. The occultation took place at 7*h*..32′..47″,8 true time nearly. The emerſion was on account of clouds not viſible. Whether this appearance of the ſtar on the moon's diſc is to be attributed only to rays forming an annulus about the diſtinct image in the retina, or to the atmoſphere of the moon deſerves enquiry, and the queſtion may perhaps be reſolved by a compariſon of this with ſimilar obſervations.

VII. *Deſcription of a thirteen foot Teleſcope, and Obſervations made through it on Saturn and the Moon. By* Jo. Hier. Schroeter.

THIS is the firſt Herſchellian teleſcope made in Germany. The tube and ſtand are of mahogany, and together weigh about three hundred pounds weight. The tube is an octagonal priſm, length thirteen feet and a half, exterior diameter thirteen digits, thickneſs of the planks $\frac{3}{4}$ of a digit. The hollow ſpeculum of a denſe white metal repreſents objects in their proper colours; its weight with the frame about twenty five pounds, diameter ten digits and a half, the greateſt chord of the poliſhed ſurface nine digits and a half, ſurface nearly parabolical. Focal length for near terreſtrial objects thirteen feet four digits, for the fixed ſtars twelve feet eight digits. At the diſtance of a hundred and forty paces, with power of fifteen hundred the ſmalleſt print may be read. This teleſcope was made by Schræder.

On the 26th of December, 1792, the writer obſerved Saturn with power about three hundred, and ſaw his belts, the ſouthern broad like a cloud, the neareſt northern much more lucid than the remaining part of the ſurface, and the ſhadows which the body caſt upon the ring and the ring upon the body. The boundaries of theſe ſhadows were jagged. The ring appeared double, the dark interval appeared much leſs diſtinctly in the preceding weſtern half of the ring, than in the eaſtern following.

On the 18th of January, 1793, the dark interval appeared on both ſides equally broad.

On the fourteenth of January, 1793, the moon being two days old, was obſerved with power of 136. The dark parts appeared clear and diſtinct, having ſpots of different brightneſs, with ſhadows of different magnitudes. Plato and the neighbouring ſpots appeared like parts illuminated by the ſun ſeen through a cloud.

On the 18th a few hours before the firſt quadrature, Ariſtarchus and the dark part of Grimaldus were clearly diſtinguiſhed, and beſides at leaſt fifty or ſixty lucid points, for the moſt part round with a red light, ſuch as the atmoſphere of the earth tranſmits to the moon. This light is owing to the greater ſplendour of the tops of the hills and craters forming the rings.

VIII. *On Æquidiſtant Curves. By* ABRAHAM GOTTHELF KAESTNER, 1793.

THE definition given by Euclid of parallel lines is clearly not applicable to curves, ſince a parabola and hyperbola on the ſame axis may never meet, yet they are not parallel. Perpendiculars to parallel lines are equal, whence they may be properly called equidiſtant lines, and if the parts of normals interſected by two curves are equal, the curves may be called equidiſtant curves. Leibnitz very improperly calls them parallel curves. The purport of this paper is the theory of equidiſtant curves.

Lemma I.

To the given lines ABCD to draw others equidiſtant at the extreme points.

Draw the lines A *ſ*, B *t*, C *v*, D *w*, interſecting each other in the points M, N, O, make AS = BT = CV = DW, STVW or *stvw* will be equidiſtant from ABCD, in the one caſe convex in the concave towards ABCD.

Let AS $= h$, A M $= a$, M B $= b$

Then $ST^2 = \overline{a-h}^2 + \overline{b-h}^2 - 2\,\overline{a-h}.\ \overline{b-h}.\ \text{coſ}\,M$

$$\text{Tang } MST = \frac{\overline{a-h}.\ \text{ſin}\,M}{b-h - \overline{a-h}.\ \text{coſ}\,M}$$

Let the angle M be continually diminiſhing and ABTS will continually approach to equality with AB + ST + $\frac{1}{2}\,h$ and the area ABCD — TS to equality with $\frac{1}{2}\,h$ + (ABCD - - + STVW - -)

Lemma II.

Let ZABCD - - be a ſyſtem of given right lines, containing given angles, required a ſyſtem of equidiſtants.

Let AB $= a$ BC $= b$ CD $= c$ - - ZAB $= \alpha$, ABC $= \beta$, BCD $= \gamma$ - - -. Biſect AB in M and draw MN perpendicular $= k$ and through N, A*B* parallel to AB and terminated by the lines biſecting the angles ZAB, ABC and ſo from B* and C* in the ſame manner the lines B*C* &c. then A*B*C* is a ſyſtem of equidiſtant lines.

Let MN $= k$ then A*B* $= a\text{-}k.\ (\cot \frac{1}{2}\,\alpha + \cot \frac{1}{2}\,\beta) = a - k.\ \dfrac{\text{ſin}\,\frac{1}{2}\,(\alpha+\beta)}{\text{ſin}\,\frac{1}{2}\,\alpha.\ \text{ſin}\,\frac{1}{2}\,\beta}$ and ſo of the reſt.

A fourth proportional to a, b, A*B* $= b.\left(1 - \dfrac{k}{a}.\ \dfrac{\text{ſin}\,\frac{1}{2}\,(\alpha+\beta)}{\text{ſin}\,\frac{1}{2}\,\alpha.\ \text{ſin}\,\frac{1}{2}\,\beta}\right)$ ∴ if B*C* is this proportional $\dfrac{b.\ \text{ſin}\,\frac{1}{2}\,(\alpha+\beta)}{\text{ſin}\,\frac{1}{2}\,\alpha} = a.\ \dfrac{\text{ſin}\,\frac{1}{2}\,(\beta+\gamma)}{\text{ſin}\,\frac{1}{2}\,\gamma}$.

The interior figure, though the lines are equidiſtant, is not neceſſarily ſimilar to it.

Let AA*, BB* meet in K, then BK $= \dfrac{a.\ \text{ſin}\,\frac{1}{2}\,\alpha}{\text{ſin}\,\frac{1}{2}\,(\alpha+\beta)}$. The diſtance of the point where BB* and CC* meet from B $= \dfrac{b.\ \text{ſin}\,\frac{1}{2}\,\gamma}{\text{ſin}\,\frac{1}{2}\,(\beta+\gamma)}$ if theſe two laſt quantities are equal, the figures are ſimilar.

Lemma III.

To the right line AB, BC, to draw MN, NO, parallel, ſo that the diſtance between AB and MN ſhall not be equal to that between BC and NO.

Let BK be drawn ſo as not to biſect the angle ABC, and join KA, KC and in BK through any point N draw MN, NO, parallel to AB, BC. the diſtance of MN = B N × ſin KBA, of NO = BN × ſin KBC, which two quantities are unequal by conſtruction.

Prop. I.

Let the diſtance of a point in the normals from a given curve be given, required the loci of theſe points.

Let the given curve be AM, AP $= x$, PM $= y$, ſubnormal PO $= \frac{y\dot{y}}{\dot{x}}$ normal MO $= \frac{y\dot{z}}{\dot{z}}$, MH $= b$ to find the loci of the points H

Let HI $= q$ AI $= p$

MO : MH : : OP : PI $= \frac{h.\dot{y}}{\dot{z}} \therefore p = x + \frac{b.\dot{y}}{\dot{z}}$

$\dot{z} : \dot{x} : :$ OH : HI $= y - \frac{b\dot{x}}{\dot{z}} = q$

Let MTP $= \zeta$ then
$p = x + b.$ ſin ζ
$q = y - b$ coſ ζ

If $\dot{z}$ is conſtant $\ddot{x} = -\frac{\dot{y}\ddot{y}}{\dot{x}}$ and $\dot{p} = \dot{x} + \frac{b\ddot{y}}{\dot{z}}$ and $\dot{q} = \dot{y} - \frac{b\ddot{x}}{\dot{z}} = \dot{y}.\left(1 + \frac{b\ddot{y}}{\dot{x}\dot{z}}\right) = \frac{\dot{y}\dot{p}}{\dot{x}}$

MH is at right angles to both curves. The ſubnormal to FH $= \frac{q\dot{q}}{\dot{p}} = \frac{y\dot{y}}{\dot{x}} - \frac{h\dot{y}}{\dot{z}}$

but IO $= x + \frac{y\dot{y}}{\dot{x}} - p = \frac{y\dot{y}}{\dot{x}} - \frac{h\dot{y}}{\dot{z}}$ ∴ IO is the ſubnormal to the interior curve.

The fluxion of FH $= \sqrt{\dot{p}^2 + \dot{q}^2} = \frac{\dot{p}\dot{z}}{\dot{x}} = \dot{z} + \frac{h\ddot{y}}{\dot{x}}$.

To find the area contained between the two curves.

$\dot{\varphi}$ Area $= \overline{\text{MH}}.\ \tfrac{1}{2}\,\overline{\text{M}m + \text{H}h} = \tfrac{1}{2}\,h.\left(2\dot{z} + \frac{h.\ddot{y}}{\dot{x}}\right) = h. + \tfrac{1}{2}\,\frac{h^2\ddot{y}}{\dot{x}}$.

An equidiſtant curve is eaſily deſcribed by the evolute of the given curve thus in Plate I. Fig. 7. Let DK be the evolute of AM, AD being the radius of curvature for the point A. ∴ MK = AD + DK and HK the radius of curvature of the curve ſought = AD — b + DK.

Inſtances of the application of theſe principles are given in various curves.

Prop. II.

Let the equation to the curve be $y = a^{\frac{1}{3}} x^{\frac{2}{3}}$ ∴ $x = y^{\frac{3}{2}}.\ a^{-\frac{1}{2}}$ ∴ $\dot{x} = \tfrac{3}{2}\dot{y}\sqrt{\frac{y}{a}}$ and $\dot{y} = \tfrac{2}{3}\dot{x}\sqrt[3]{\frac{a}{x}}$; $\dot{z} = \dot{y}\sqrt{1 + \frac{9}{4}.\frac{y}{a}} = \dot{y}\sqrt{\frac{4a + 9y}{4a}}$

Subtangent $= \tfrac{3}{2}x$ Subnormal $= \tfrac{2}{3}\sqrt{ay}$ Normal $= \frac{\sqrt{9y^2 + 4ay}}{3} = \sqrt{y}.\ \frac{\sqrt{4a + 9y}}{3} =$ N

Let $a = 1$. then $AO = x + PO = \overline{y + \tfrac{2}{3}}. \sqrt{y}\ p = x + \frac{2.\ b\ \sqrt{a}}{\sqrt{4a + 9y}} = x + \frac{2.\ b\ \sqrt{ay}}{3.\ N}$ $= y - \frac{3b.\ \sqrt{y}}{\sqrt{4a + 9y}} = y - \frac{b\ y}{N}$

q When $y = 0$, $p = b$, and $q = 0$. p is always poſitive, and greater than x, but q vaniſhes with y, and when $b = N$ $\therefore 9 b^2 = 4 ay + 9y^2$ $\therefore y =$ $\frac{-2a + \sqrt{4a^2 + 81 b^2}}{9} = c$ $\therefore x = \sqrt{\frac{c^3}{a}}$ and $p = \sqrt{\frac{c^3}{a}} + \frac{2}{3} \sqrt{a.c}$

As long as the normal is leſs than b, q is negative. Let $\therefore$ AF $= b$, AE $=$ leaſt value of p, AC $= p$ when $b = N$. Then the equidiſtant begins at F, is concave towards the given curve from FG, at G has a cuſp, and becomes convex towards the given curve, the ordinate is negative to C, and then poſitive.

The writer calculates ſeveral values of q, p, &c. in logarithms, but it is needleſs to inſert them, as every reader, acquainted in the leaſt with the mathematics, can now ſee the whole of the method.

Inſtances are alſo given of equidiſtants from the common parabola and the curve, whoſe equation is $y^2 = b.x - \frac{b}{a}. x^2$

HISTORICAL AND PHILOLOGICAL CLASS.

IX. *A Commentary on the Works of Ancient Art, recorded to have been extant at Conſtantinople.* *By* CHR. G. H. C. HEYNE.

IT is well known that the emperor Conſtantine, as well for the purpoſe of adorning his new city, as for the depreſſion of heatheniſm, cauſed a vaſt number of the moſt celebrated works of art extant in the temples and public places throughout the Roman empire, to be conveyed to Conſtantinople. But beſides theſe, we learn from writers, that there were in the ancient Byzantium ſeveral edifices and ſtatues of note which ſubſiſted to later times. The learned profeſſor in this Commentary collects all the memorials of works of art, from both the above ſources, which are found in writers of different periods who deſcribe that metropolis. As his paper is little more than a catalogue, it is incapable of abridgment; we ſhall therefore content ourſelves with a general ſketch of its contents.

The bath called Zeuxippus, and the Hippodrome, were peculiarly rich in works of ſculpture. Of the brazen ſtatues in the former there is extant an enumeration in Greek verſe by Chriſtodorus the Coptite, which affords a copious liſt to our commentator. He goes through, in his firſt ſection, thoſe of the male deities, heroes, perſonages engaged in the Trojan war, poets, philoſophers, orators, and illuſtrious men, mentioned as well by Chriſtodorus, as by other writers. In the ſecond ſection, he treats in a ſimilar order of the female ſtatues. He then enumerates the obeliſks, columns, gates, figures of animals, and other monuments which Conſtantinople contained in the Hippodrome and other public places.

X. *A Commentary on the Works of later Art recorded to have been made under the Byzantine Emperors. By the Same.*

THE Profeſſor begins the firſt ſection of this paper with an enquiry into the cauſes of that decline of the arts, which is manifeſted in the works of this later period. Theſe he ſuppoſes to have been, the depraved taſte of the times proceeding from luxury and Aſiatic manners—the prevalence of the Chriſtian religion, which deprived the artiſts of their ſplendid ſubjects derived from heathen mythology, without, at firſt, ſubſtituting any in their place—the gradual diſuſe of the cuſtoms of erecting ſtatues to illuſtrious men, and the change in habits, manners, &c. which rendered them worſe ſubjects for the graphical art. He then enumerates the recorded ſtatues of different emperors. In the ſecond ſection he proceeds to thoſe of illuſtrious perſons of the male ſex; and concludes with thoſe of the female ſex in like order. It is remarkable that ſcarcely any ſtatues of Chriſt and the Apoſtles appear to have exiſted at theſe periods.

XI. *On the Commerce of the Greeks with India. By* A. H. L. HEEREN.

IT is doubtful, what merchandiſe firſt came into Greece from India. We read of ivory in Homer, but this might come by the way of Egypt or Arabia from Ethiopia. Beſides ivory, we know of nothing in the age of Homer, which might be eſteemed peculiar to India; the only ointment uſed was oil, and ſpices of all ſorts ſeem to have been unknown.

In the great convulſions, which took place in Aſia, between the times of Homer and Herodotus, the wealth of India can ſcarcely be ſuppoſed to have remained untouched or unknown. The Phœnicians probably never traded directly with India, but received its commodities either from Arabia, or from their colonies at Tyre and Aradus in the Perſian Gulph. That the Chaldæans in the flouriſhing ſtate of their government, before the times of Alexander, carried on by the Arabian Gulph, a great trade with India is probable on two accounts. 1ſt. To obſtruct the navigation up to Babylon, the Perſians by artificial falls rendered innavigable the mouths of the Euphrates and the Tigris. 2dly. At Gerrha on the Perſian Gulph was a colony planted by the Chaldæans, and the trade of that place, as deſcribed by the ancients, is a clear proof that the colony was planted for the ſake of commerce.*

Hence by means of the Babylonians, the merchandiſe of India was conveyed through Aſia, and came to the Greeks, but for want of authentic monuments, the mode is not exactly known. Formaleoni † indeed advances a ſuppoſition, that at this time there were Grecian colonies on the Black Sea, who carried on the Indian trade by means of the Caſpian Sea, and the river Cyrus, made navigable by Jaſon and his companions, tranſmitting their goods to Phaſis and thence to Pontus. But the ſlight foundation on which this opinion reſts, ſimply the place in Strabo, mentioning the report that the river was made navigable by Jaſon, renders it unneceſſary to dwell upon this point. ‡

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* Strabo. p. 1210. 1059.

† Storia delle colonie Greche ſul mare nero, Vol. I. p. 11.

‡ Strabo. p. 762.

Under the Perſian empire founded by Cyrus, the trade with India was probably very ſmall, for we learn from Herodotus, that the navigation of the Phœnicians in the Arabian Gulph ceaſed ſoon after the times of Necho, and their trade in general muſt have been materially injured, from the repeated attacks on them by the Babylonians and Egyptians.[*] Excepting alſo the expedition of Scylax, there ſeems no trace of navigation on the Arabian Sea, ſo that in the time of Alexander, the way from the Arabian to the Perſian Gulph was entirely unknown. The Indian navigation by the Perſian Gulph, and the two rivers to Babylon was deſtroyed as before mentioned, by the falls made at the rivers mouth.[†] But though the maritime trade was at an end, there was a conſiderable one over land. Darius Hyſtaſpes made the nations bordering on the Indies, his tributaries, and from the remains of Cteſias it appears, that the gold, ivory, gems, ſugar canes, parrots and other commodities from the north of India, were known to the Perſians.

Though the Perſians neglected this trade, it enriched, according to Strabo, the Gerrhæans, who carried it on [‡] partly by the interior parts of Arabia, and partly by the Euphrates. Above the cataracts was built a town, ſerving as their emporium, where the commodities of India and Arabia were embarked on the Euphrates, and conveyed into the interior parts of Aſia [§]. By means of Arabia and the Phœnicians, the Greeks had beſides gold and ivory, cinnamon, and other commodities of India; for before the time of Alexander they were acquainted with the uſe of pepper, though as it is called Lybian pepper, a doubt ſtill remains whether it came from India.

In this ſtate was the Indian trade at the time of Alexander, whoſe intention it was to make Babylon the metropolis of his new empire, and to open again this commerce. With this view he built ſeveral towns on the banks of the Indus, and in the interior parts of Aſia, ſo that there might be an open road through the continent of Aſia, from the Indus to Babylon.[**] Nearchus explored the way by ſea through the Perſian Gulph from the Indus to the mouths of the Euphrates, and was ordered to find out another alſo from the Euphrates to Egypt: and Alexander himſelf ſuperintended the opening of the entrance into the Euphrates and Tigris.[††]

The confuſion enſuing upon his death naturally interrupted the commerce for ſome time, but Seleucus Nicator, and Ptolemy Philadelphus encouraged it, the one by ſea the other by land. Seleucus indeed not only carried his arms into India, but made an alliance with Sandrocotto king of Palibothra.

During the whole of this period, the peninſula of India was unknown to the Greeks, and the trade was chiefly confined to the north of India, to the country between the Ganges and the Indus. In thoſe regions Alexander built ſeveral towns, whoſe names, except that of Pattala, were loſt, as the Greeks after his time penetrated farther into the interior of India, and built ſeveral cities on the Ganges. Among theſe are moſt diſtinguiſhed Palibothra near Patna, Callinypaxa, the modern Canoge, and Ganga below Palibothra. In theſe towns the Greeks met the merchants of India, and among the Praſian Indians, whoſe capital was Palibothra, we learn from Megaſthenes, that there were laws for the regulation of commerce, and magiſtrates to inſpect the meaſures and commodities.[‡‡] From Palibothra to Taxila, where Alexander paſſed the Indus, was a high road by which the commerce of India was eaſily conveyed from the Ganges to the Indus, and thence into the interior parts of Aſia.[¶] The firſt mention of this road is made by Eratoſthenes, who ſeems to have copied Megaſthenes, and as the Perſian kings never came near the Ganges, nor is it taken notice of by the companions of Alexander, it is probable that the road was made in the time of Seleucus Nicator, for the benefit of the commerce between the kings of Syria and India.

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[*] H. 159.

[†] Strabo. p. 1059.

[‡] Strabo. p. 1110.

[§] Strabo. p. 1059.

[**] Strabo. p. 1026.

[††] Strabo. p. 1076.

[‡‡] Plin. VI. 22. vol. 1. p. 322. Strabo, p. 1034.

From India commodities were diſperſed through Aſia and ſo to Greece by different ways. 1ſt. The traders went from Taxila on the Indus to Alexandria in the Paropamiſus, thence to Alexandria in Arachoſia, and leaving the deſerts of Carmania on the left, through Prophthaſia, to Alexandria of Ariana. Hence the way was open through Perſia and Suſiana, towards Babylon or Seleucia. This was the ſhorteſt way, but as the whole was land carriage, and conſequently required both time and expence, and beſides was much expoſed to the incurſions of robbers among the Elymœans, Parætaceni, and Uxii, it was but little frequented.

2. A ſecond way was from the mouths of the Indus to the Euphrates. This was explored by Nearchus; and the ſhips, according to Pliny and Diodorus,[*] took their departure from Pattala or Potana, built by Alexander at the mouth of the Indus. Some went up the Euphrates to Babylon, others the Tigris to Seleucia. Strabo has deſcribed the road from Babylon to the Mediterranean.[†] On leaving Babylon or Seleucia, the merchants went to Scenæ, belonging to the Scenite Arabians, on the confines of Meſopotamia. In twenty-five days they paſſed through the deſert towards the north, purchaſing their ſafety for a moderate tribute from the Arabians; then paſſing over the Euphrates at Anthemuſia, and avoiding the borders of Arabia, they went through Syria to Antioch, and the towns on the Mediteranean, from whence they embarked their goods for Corinth, and on its deſtruction for Delos, and thus diſperſed them through Europe and Africa.

3. A third way was through the Caſpian and Euxine Seas. From the Indus to the Hyrcanian Sea were two ways, the one entirely by land, the other almoſt wholly by rivers.[‡] From Strabo, we learn that the former road went from the Caſpian Sea, through the Caſpian gates, and Parthia, to Alexandria in Ariana. There it divided, the ſtraight road going through the Paropamiſus, to Orthoſpana or Carara now Kare, it lat. 32°, and thence to the Indus. The other bending a little to the ſouth, went through the territory of the Drangæ and Prophthaſia, to Alexandria in Arachoſia, and thence to the Indus. This road from the Caſpian Gates to Alexandria in Arachoſia was made by Alexander.

The way for water carriage by the Oxus or modern Ghion is deſcribed by Strabo and Pliny[§]. From the Indus, according to Pliny, the merchandiſe was carried by land in ſeven days to the river Icarus, the modern Arrat or Irat, near whoſe banks was Bactra, ſtill famous for its trade, and thence by water to the Oxus, and down this laſt river to the Caſpian Sea. But as it appears by Rennel's map, that the Icarus is more than two hundred geographical miles from the Indus, it is probable, that by the Indus here is meant ſome one of the rivers, flowing down the Paropamiſus into it, and as Cabul, a town at preſent famous for its trade, is ſituated on the Gureus, the modern Attock, we may reaſonably ſuppoſe, that the ſhips went from the Indus, up the Cabul, where the commodities being diſembarked were

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[¶] Strabo. p. 1010.

[*] Plin. VI. 23. p. 327. Diod. III. p. 181.

[†] Strabo. p. 1084.

[‡] Strabo. p. 1053.

[§] Strabo. p. 776. 777. Plin. p. 315.

tranſported over land to Bactra, on the Icarus, the diſtance being not more than fifty geographical miles, to be travelled over conveniently in ſeven days.

The trade thus brought to the Caſpian ſhores was embarked on larger veſſels, and conveyed to the weſtern ſide of the Hyrcanian Sea, and entered the mouths of the Cyrus, or modern Kur. From thence it was conveyed in five days by land carriage, to the Phaſis, by this river down to the Euxine Sea, where being embarked in ſhips, in two or three days ſail, it arrived at Sinope, or Amiſus, ports of the Greeks.

This way was frequented by the Greek Merchants from the time of Seleucus Nicator; for Strabo, deſcribing it, quotes as his authorities, Ariſtotle, and Eratoſthenes, who both gathered their information from the commentaries of Patroclus, who was præfect of the ſuperior Aſia, under Seleucus Nicator. The Aorſians might here be mentioned, who dwelt between Pontus and the Caſpian Sea, and were enriched according to Strabo, by the Indian trade. Comana in Media, was the mart which they frequented, from whence they carried the commodities of India on camels to the Euxine.

4. The fourth way for the commerce of India, was by Arabia, and was carried on by the Gerrhœans and the Sabœans.

In the time of Alexander the commerce of the Gerrhœans was in a very flouriſhing ſtate. They traded directly with India, by means of the Perſian Gulph and Indian Sea, and conveyed ſpices of all ſorts, and pearls, for which the Perſian Gulph is remarkable, either to Petra, a famous mart of the Nabathæi, where they were purchaſed by the Phœnician merchants, or to Ælath in the Arabian Gulph, whence they were ſent into Paleſtine; or they bartered their ſpices for jewels and gold, in the interior parts of Syria and Meſopotamia. This trade began in the time of Cyrus, and continued to flouriſh to that of Strabo.[*]

It is doubtful at what time the Sabœans, under which name are comprehended all the tribes on the ſouth weſtern coaſt of Arabia, carried on trade by ſea with India: By conjecture from Herodotus, we may ſuppoſe it to have taken place before the time of Alexander;[†] for, in enumerating the commodities brought by the Phœnicians from Arabia, he mentions cinnamon, which being a produce of India, and the Arabians allowing it to come to them from diſtant parts, was moſt probably brought from India by the Sabœan merchants. Beſides the teſtimony of antient writers, that the Sabœans were in the time of Alexander, the richeſt people in the world, leads us to imagine that this wealth was obtained by Indian commerce.[‡] In the towns of the Sabœans, were common marts for the merchandiſe of India and Egypt, frequented by the Indians themſelves; and the authority of Bruce, though he ſeems miſtaken in ſuppoſing that the Africans ever went to India, may be quoted for the antiquity of the commerce carried on by the Sabœans.

From the ſhores of Arabia, the merchandiſe of India was carried over land to the Mediterranean. At Petra a town of the Nabathœans, was a famous mart to which the Sabœans carried their goods, and from thence into Syria and Meſopotamia.[¶] The whole journey was performed in caravans of camels, which bore the appearance of an army.

Beſides Petra, the merchandiſe of the interior parts of Arabia, was carried to

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[*] Agatharchides in Geog. Min. vol. 1. p. 64.

[†] Herod. III. 111.

[‡] Strabo. p. 1110. Diod. L. 111. p. 180.

[¶] Strabo. 1123. Diod XIX. 731. Plin. 1. 336.

Elana or Elath, on the bay of that name. The journey according to Strabo from the northern to the ſouthern extremities of Arabia, was performed in ſeventy days, and the Gerrhœans came to Chatramolitis in forty days. * From Elath there were two ways to the Mediterranean, the one to Gaza, the other to Heroopolis on the Nile.

5. There remains a fifth way to be conſidered, by which under the Ptolemies the ſhips of the Greeks arrived in India. This ſubject has been well treated of by Schmidt, from whom we differ only in our opinion, that the navigation to India, inſtead of being common under Ptolemies, was little uſed till the time of Auguſtus.†

By order of Philadelphus the Arabian Gulph was explored by Ariſto as far as the Neptunian Streight, now called Bab-el-mandel. ‡ The way being thus opened, ſome ſhips went on farther, and approached India, but by the teſtimony of Strabo, theſe were few in number. ¶ Firſt, ſays he, under the Ptolemies, very few had courage to ſail to India, and import its commodities; and in another place, formerly not twenty ſhips dared to croſs the Arabian Sea in a year, now they go in large fleets. From the hiſtory of Eudoxus it appears, that after the time of Philadelphus, this navigation ceaſed, till it was renewed under Evergetes the ſecond; and if this account ſhould appear improbable, though related by Poſidonius, a cotemporary of Eudoxus, it is certain that the way to India was not generally known. This is eaſily accounted for, when we conſider the danger to which it was expoſed. In our own times, and with our ſuperior knowledge, the navigation of the Red Sea is dangerous, and to the danger of the ſeas muſt be added the piracies of the Nabatheans. § As the veſſels could not launch far out into the deep, they were obliged to coaſt along the rocky ſhore of Arabia. In looſing from the Syagrian port, they made for Pattala, or Pattallena, near Cana, a town of the Chatramotites. In the time of the Romans, they went from the ſame port to Zigerus, a port of India, according to Pliny, and it was probably known in the time of the Ptolemies. The ſituation of Zigerus mentioned only by Pliny is doubtful. Strabo ſpeaks of the kingdom of Sigertis beyond Patala, in which Schmidt places the promontory of Zigerus, but then it lies too much to the ſouth to be reconciled to Pliny's words, that this was the neareſt courſe.**

From the above we may conclude, that the Grecian ſhips ſailed to the mouths of the Indus, and the neighbouring ports, but whether they went round the peninſula of India, to the iſland Taprobanes, and the mouths of the Ganges admits of doubt. In Strabo's time very few made that voyage, whence it was ſcarcely common under the Ptolemies.††

For the commerce from the eaſtern ſhore of Egypt, to the Nile, ports were fixed by the Egyptian kings, among which Berenice and Myos Hermos were diſtinguiſhed. Theſe towns were at the extremity of the Red Sea, near the iſthmus, from whence merchandiſe was conveyed by the ſhorteſt way to the Nile. According to Strabo, the iſthmus was between Berenice and Coptus, the former being near Myos Hermos, and oppoſite to Coptus, but modern geographers d'Anville, Blairs, and others, place Berenice in the oppoſite extremity of Egypt, and in the ſame latitude with Syene. The fact is there were two Berenices, the one called Berenice Philadelphi, of which

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* Strabo. 1113.
† De commerciis et navigatione Ptolemæorum.
‡ Diod. iii. 175.
¶ p. 179 and 1179.
§ Diod L. iii. p. 176.
** Plin. VI. vol. 1. p. 328.
†† Strabo. p. 1006.

Strabo ſpeaks, near Myos Hermos, the other Berenice Troglodytices, to the ſouth oppoſite Syene. Goods therefore coming from India were landed at Myos Hermos, or Berenice Philadelphi, and from thence were conveyed in ſix or ſeven days on camels to the Nile, on which they were embarked in ſhips and carried down to Alexandria.

XII. *On the Knowledge which the Romans had of India.* *By* A. H. L. Heeren.

MUCH light has been thrown on this ſubject by three works lately publiſhed, the one in Britain by Robertſon, another in France by Goſſelin, a third in our own country by Sprengel.* There are ſtill great difficulties attending it, for the Romans went to India only for the ſake of commerce, having never carried their arms into that country, nor undertaken any voyages to explore it. In vain then do we ſeek among the Romans for ſuch writers as Herodotus, Cleoras, Megaſthenes, Daimachus, and others, which Greece produced. Our remarks muſt be taken from what Mela, Pliny, Ptolemy, and Arrian, have gleaned from others, and left upon this ſubject.

According to the account of Mela, the eaſtern part of Aſia was in the poſſeſſion of three nations, the Scythians, Seres, and Indians. The Scythians, diſtinguiſhed by the names of the Androphagi and Sacæ, lived to the north, between the promontories called the Scythian and Tabis. From the territories of the Sacæ to the Tabis are vaſt deſerts. At this promontory begins the country of the Seres, reaching to the extremity of Mount Taurus and the eaſtern ocean. Next to them are the Indians, bounded towards the north by the Taurus, and its extreme promontory Tamos or Imaus. At the ſouthern extremity is the promontory Colis. Between the Indus and Colis is the Ganges, deſcending from Mount Hœmodus, and emptying itſelf by ſeven channels into the Indian Ocean. The Indus takes its riſe in the mountain Paropamiſus, and empties itſelf into the ſea by two mouths, at a great diſtance from each other. The iſlands oppoſite to the continent are Chryſe, near the Tamos, in the eaſtern ſea, Argyre by the Ganges, Tapobrane, Patalene by the mouths of the Indus, and the iſlands of the ſun. Nyſe, famous for the ancient ſtory of Bacchus, is the only town mentioned. The Palibothri poſſeſs the country from the Indus to the Ganges: from the Ganges to the promontory Colis are blacks: from Colis to Cudum, whether a town or a mountain it is not known, live a people naked. Theſe are the chief things related by Mela concerning India; of which he has given a more accurate account than Strabo, though much is grounded only on conjecture. By the Scythians he means the Monguls, the Sakœ lived by the Jaxartes, and their name ſtill exiſts in the country Sakita. The Androphagi are the inhabitants of the northern part of Aſia. Whether by the Scythian promontory we muſt underſtand Kamſchatka is doubtful, but the vaſt deſerts near Serica are the deſert Kobi, called Chamo by the Chineſe, bounding China on the north, and Tabis is the Corea. Hence the Serica of Mela is to be put in the northern part of China, though it comprehended the whole of the Chineſe empire, whoſe limits were then unknown. Tamos is not now to be pointed out, as there are no diſtinguiſhable promontories in the mountains of Taurus or Imaus. His idea of India was falſe, as he gives it a ſouthern and eaſtern ſide, placing Colis or Cape Comorin in the point of the angle. His iſlands Chryſe and Argyre are clearly fabulous, and his iſlands of the Sun are to be found on the Malabar coaſt, or not at all. His account of the inhabitants is ſomewhat clearer. The Palibothri are the ſame as the Praſii: the blacks were a ſavage race, under the name of Papuas or Haraſoras, whoſe poſterity ſtill exiſts in Sumatra, and the adjacent iſlands: and his naked people on the eaſtern ſhores, are the ſame as the Siameſe and Malays.

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* Robertſon's Hiſtorical Diſquiſition on the Knowledge which the Ancients had of India. Goſſelin Geographie des Grecs Analyſée. Sprengel's Geſchichte der geographiſchen ent-deckungen bis auf die ankunft der Portugieſen in Japan.

Though in the time of Pliny, they ſailed directly from the Arabian Gulph to the peninſula of India, and ambaſſadors had come from Taprobane to the emperor Claudius, the knowledge of India was very little improved. He compiles his account from Megaſthenes, Hipparchus, and others among the Greeks, Mela and Seneca among the Romans, but without judgement or order. According to him the Scythians poſſeſſed the northern parts of Aſia, between whom and the Seres was a vaſt deſert. From the merchants trading with the latter nation, he gives the names of ſome rivers Lanos, Atianos, Cambari, and Pſittaris, with thoſe of the promontory Chryſe, and bay Cyrnaba. Theſe rivers are in the kingdom of Tangut, bordering on Chen-ſi, a weſtern province of China. Lanos is the preſent Olan, Atianos, Aytan: Cambari and Pſitari muſt be the Etzinié: Chryſe and Cyrnaba are unknown, but the mention of the bay Cyrnaba proves that Serica was ſuppoſed at that time to be bounded by the ſea.

Next to the Seres are placed the Attacori or Attacorori, on whom Amometus compoſed a book, and they are ſaid to live ſhut up by hills from every noxious blaſt; from whence we may conclude them to be the inhabitants of Thibet. After the Attacori come the Phruri and Tachuri, now not known. Towards the weſt, in the interior of Aſia, are placed the Caſiri, called Anthrophagi, without doubt the inhabitants of Caſhgar or Caſia.

On the figure of India he gives nothing new, and his account of the nations is ſo confuſed, that it is impoſſible to aſſign to each its reſpective place. Behind Mount Emodus, bounding India to the north, are the Iſaci and Izygi: next to them the Coſyri and Chiſiotoſagi; the former are to be looked for on the weſtern bank of the Indus, in the regions of Iſſaki and Ghizni; of the latter we can give no account. Then come the Maccocalingæ by the ſea of Calinga, and above them are the Mandei and Mallei; the latter were inhabitants of Moultan. The Maccocalingæ are reckoned among the Brachmans, a name common to many nations between the Ganges and Emodos, and traces of their name ſeem to exiſt in the town of Callinger, in the kingdom of Oude, near Ahallabad. The Praſians, whoſe capital was Palibothra, are ſaid to be ſuperior to all the other nations of India. By the mouth of the Ganges are placed the Gangaridæ Calingæ, to be traced in the region of Ghergong, between the Ganges and Burrampooter. Pliny gives a falſe figure to the ſouthern ſide of India, ſuppoſing it to run to ſome extent in a ſtraight line. Between the Indus and Iomane, in the land of Agemere, are placed the Caſii, Cetroboni, and Megallæ. Near the Indus live, ſurrounded by mountains and deſerts, the Chryſei, Aſargæ, Paraſargæ, Dari, and Suræ, who lived therefore between the Paropamiſus and the deſerts ſeparating Multan and Guzerat. Towards the ſouth, within the peninſula,

ninſula, are the Maltacoræ, Singæ, and others not now to be traced out. The Aſoni may, however, be mentioned, whoſe capital was Bucephala, built by Alexander, near the river Aceſine, the Taxillæ, with their town Taxila, the modern Attoch, the Pencolaitæ and Arſapolitæ, are the inhabitants of Pehkely and Aſthagur.

His deſcription of the iſland Taprobane is taken from the accounts, evidently fabulous, given by the ambaſſadors to Claudius. What they ſaid on the obſervations of the ſtars, does not agree with the ſituation of the iſland; and their aſſertion that one of its ſides was ten thouſand ſtadia long, is equally incredible. We can ſay nothing of the lake Megiſba, and the two rivers Palæſimundus and Cydora, as the interior parts of Ceylon have not been ſufficiently explored.

The account given of India in the periplus of the Red Sea, vulgarly attributed to Arrian, is much more accurate. The author knew its true figure, and that its ſouthern extremity was not a ſtraight line: the name of the Decan was alſo not unknown to him, which he calls Dachan, and the coaſt is ſtill called Dachan-abadey. He begins with the Indus, which he calls the Sinth, and deſcribes the Malabar coaſt in a manner eaſily to be followed. There are ſeven mouths given to the Indus, the middle, now called Ritchel, being the only one navigable. On this was ſituated the mart Barbari, or Barbaricum, in the interior parts Minnyara, but of neither do any traces remain. Behind the Indus is the bay Eirinus, now the gulph of Cutch, above which is the promontory Barace, now called Barce, with ſeven iſlands. As the river Paddar is not mentioned, this gulph had not been accurately ſurveyed. Three thouſand ſtadii from Barbaxi was the town and river Barygaza, in the gulph of the ſame name, evidently from the diſtance the gulph of Cambay, and Barygaza is the preſent Beroach. Two rivers run into this bay Mais, now Myhie, and Lamanus now Nerbuddah. Going eaſtward from this bay, we come to Ozene, now Ougein, on the river Sepra, which runs into the Nerbuddah. Above theſe is placed Bucephala and the Bactrians, from whence it is evident that the interior parts were known only by report. The ſhore from the bay of Barygaza ſtretches out in a ſtraight line to the ſouth, and the country is called Decan. In the interior are two famous marts Plutana, twenty days journey ſouth of Barygaza, and Tagara, ten days diſtant from Plutana, not eaſily acceſſible, from the hilly nature of the country. Plutana we may place in the Godavery, and Tagara is the ancient Deoghir, near which is Aurungabad, the preſent capital of the country. The hills pointed out are evidently the Ghauts. Coaſting along from Barygaza, we come to Atabarus, Uppara, and Calliena, the modern Callian, near Bombay. Mandragora and Melizigara ſeem to remain in Mandgur and Mayagoron. The iſland Seſeſoriana with others, that is Salſette, Bombay and the neighbouring iſland, is ſaid to be near the ſhore. Limyrica, ſeven thouſand ſtadia from the Indus, and conſequently four thouſand from Barygaza, is the territory now called Canara, in which are Tyndis, Muziris, Nelcynda, and Baraze. Muziris is the preſent Merzée, Tyndis being five hundred ſtadia to the north, muſt be Soonda. The name of Nelcynda is loſt; but as it is as many ſtadia to the ſouth of Muziris, and a hundred and twenty ſtadia from the ſea, near the river, at whoſe mouth is Barace, our Barcelore, Nelcynda muſt have been near Bedanore. In the territory of Pandionis are three marts: Colchi, the preſent; Cochin Balita, perhaps Ballia-got; Comar, the preſent Cameran, for the following account ſcarce allow us to ſuppoſe it Cape Comorin. On the three towns Camara, Poduca, and Sopatma, nothing can be affirmed, unleſs Comar is Cape Comorin, and then Camera may be the modern Cameran. Here ends the weſtern ſhore. Turning to the eaſt, we come to Taprobane, whoſe ſituation is properly deſcribed to be oppoſite Cape Azania, and the country of Maſadia, now called Madura. Deſarena ſeems to be our Tanjore, beyond which our author's accounts are not to be depended on, and his great merit conſiſts in having given ſo good a deſcription of the coaſt of Malabar.

After the excellent comments of D'Anville on Ptolemy's account of India, it will be unneceſſary to add much here; we may obſerve, however, that Ptolemy was miſtaken in the poſition of the interior part of India, as he places the mouths of the Indus at 20° lat. inſtead of 25°, and makes it extend to 14° inſtead of 8°.

On the parts without the Ganges, we cannot rely entirely on D'Anville. He contends that the golden Cherſoneſus is the peninſula of Malacca, Cochinchina the country of the Sinæ, whoſe capital, Thinæ, is the preſent Thoan-Hoa. The Sabaracan bay, the gulph of Martaban, the Perimulican, the ſtrait between Malacca and Sumatra, and the great bay, the gulph of Siam. The river Daona, the Tanaſſerim, and the Serus, a little river near Thoan-Hoa. But this account depends not on aſtronomical obſervations, nor on the compariſon of name, but ſimply on the compariſon of Ptolemy's map of the golden Cherſoneſus, with the modern maps of Malacca. Ptolemy could not have known the river Dava, and the river Pegu is without any grounds made to be the Beſynge. Daonis, according to Ptolemy, went into the great gulph, and is confounded with the Tanaſſerim, which flows into another. In vain we look for Ptolemy's three rivers of Cherſoneſus in Malacca, and there is no trace of the Serus near Thoan-Hoa.

According to Goſſelin, Cherſoneſus is Pegu, the land of the Sinæ, Siam, extending to Malacca, whoſe capital was Thinæ, the modern Tanaſerim, with its port Mergi, formerly Caſſinara. Malacca, Sumatra, &c. he ſuppoſes unknown to Ptolemy. The river Beſynga, now called Aracan, is traced in the iſland Beting at its mouth. The Daona, now Dava, has its name preſerved in the neighbouring town Dana-plu, whoſe three mouths are the three rivers of Cherſoneſus. The Doriſcus is the Pegu, the Serus near Thinæ, the Tanaſſerim. The bay Sabaracus is now that of Botermango, and the great bay, which D'Anville took for the Sabaracan, is the Martabanus.

The opinion of Goſſelin ſeems confirmed, 1ſt, by the names. Baracura is now called Baracoon, the Beſynga, Beting, Baraba, Barabon; the name of Seri exiſts in Siriam, of the Sinæ in Siam, and in Tana-ſerim, i. e. the people of Tanœ, the metropolis Thinœ.

2. The deſcription of places agrees with that given by Ptolemy. The Cherſoneſus is diſtinguiſhed by three rivers. Now the peninſula of Pegu is formed by the bay of the Ganges and Martaban, and in it are three rivers, or rather three branches of the Dava. The territory of the Sinæ is placed towards the ſouth, and an unknown country to the eaſt; the Seres to the north, and the great bay to the weſt; all which agree with Goſſelin, and oppoſe D'Anville. For Siam is waſhed by the ſea towards the weſt, the unknown countries are Cambian and Cochinchina, and to the ſouth Malacca. But if, with D'Anville, we make Cochinchina the ſeat of the Sinæ, how can they be bounded on the weſt by the ſea, and on the eaſt by land? The teſtimony of Marinus, preſerved by Ptolemy, confirms the opinion of Goſſelin, for they, he ſays, who went from Zaba, i. e. Bragu, to Cattigara, a part of Thinœ, now Mergi,

kept a ſouthern courſe, veering a little to the left, which muſt bring them to Siam, not Cochinchina.

3. The latitude of Thinæ, given by Ptolemy, if the paſſage is correct, puts an end to the diſpute. The longeſt day at Thinæ is ſaid to be 12*h*..47′..30″, conſequently the latitude is 13°½, which agrees with the ſituation of the preſent Tanaſerim. But this paſſage is doubtful, as Ptolemy elſewhere places Thinæ in 3° latitude.

Hence we may aſcertain the knowledge which the Romans had of India. Beginning with the north-eaſt of Aſia, they were acquainted with Serica or Tongut, to which they travelled through the deſert Cobi, and became conſequently acquainted with the adjacent country of China, and heard ſomething of the Corea; but the interior parts of China, and the limits of Serica were unexplored by them. The country between China and India was unknown, unleſs the Attacori are allowed to be inhabitants of Thibet. They were better acquainted with India than the Greeks. Their ſhips coaſted along Malabar, and ſailed into the Ganges, from whence they paſſed over the gulph to Pegu, Siam, and Tanaſſerim, on the borders of Malacca, but it is not probable that they ever ſailed round Malacca, or got ſo far as China.

XIII. *On the Veſtiges of the Religion of Zoroaſter among Foreign Nations. Commentary I. containing Hiſtorico-critical Obſervations concerning Zoroaſter, and his Writings and Doctrines.* By THO. CHR. TYCHSEN.

SECT. I. of this memoir treats on the age and country of Zoroaſter. The author declares himſelf of the opinion of thoſe who ſuppoſe Zoroaſter to have been a Mede, and to have founded his religion before the time of Cyrus. He rejects the notion of his having lived ſo late as the reign of Darius the ſon of Hyſtaſpes, for the following reaſons. 1. That upon this ſuppoſition it is impoſſible to account for his being referred to a period ſo remote, by the moſt ancient authors, as well as for the ſilence of Herodotus concerning him, who muſt have been nearly his cotemporary. 2. That this opinion entirely depends on the authority of ſome later writers who repreſent Pythagoras as having been inſtructed in magic at Babylon by ſome perſon of a name having a remote ſimilarity to that of Zoroaſter, none but Apuleius affirming it to be really the ſame. The eaſtern writers, whoſe authority is cited on the ſubject, differ from each other ſo much as to deſerve no regard. 3. From the conſent of all oriental writers, the religion of the Magi belonged to Media, not to the ancient Perſians, among whom the Magi appear to have been ſtrangers. It was in Media and Bactriana that Zoroaſter eſtabliſhed his rites, and the cotemporary king Guſtaſp is to be ſought among the ſovereigns of that country, before it came under the dominion of Cyrus. 4. The whole ſeries of Keanidian kings recorded by the oriental writers is ſo extremely different from thoſe mentioned by the neareſt Hebrew or Greek writers, that the ſeries muſt be a mere fiction, or elſe it muſt be referred to the kingdom of the Medes and the eaſtern regions of Perſia. Foucher's opinion that the Guſtaſp of the Zend is the ſame with Cyaxares I. king of the Medes, is not without probable arguments to ſupport it. 5. The language in which the books of Zoroaſter were written, widely differs, not only from the modern Perſic, but from the ancient. It is more probably Median, which tongue it is not likely that Zoroaſter would have employed, had he lived in the flouriſhing periods of the Perſian power.

With reſpect to the books brought from India by Mr. Anquetil under the title of Zoroaſter's, this writer gives the following reaſons for believing them genuine. In their matter they agree with what might be ſuppoſed of an early age. The language and mode of writing are evidently of the moſt ancient kinds. As it is certain that Zoroaſter left writings behind him, there ſeems no more reaſon to doubt that theſe might be preſerved among an uninterrupted ſacerdotal order, than that the Jewiſh ſcriptures might from a more remote period be ſo preſerved. The modeſty of the confeſſion, that not all the books of Zoroaſter, but only one called the *Vendidad*, are remaining, does not look like impoſture. Its pretenſions to authenticity are alſo confirmed by the teſtimony of Maſud, a celebrated writer in the 10th century, made public by Mr. De Guignes, who ſays that one book only of the Zendaveſta was preſerved and read by the Perſians in Segeſtan, the ſubject of which correſponds with that of this. With regard to the other liturgic books publiſhed by Mr. Anquetil, this writer ſuppoſes that they may contain paſſages of the books of Zoroaſter, but that they were compiled by the Magi for the purpoſe of public worſhip. But though he thus agrees in opinion with thoſe who contend for the antiquity of the Zendic books, he thinks that an accurate knowledge of the tenets of Zoroaſter cannot be derived from them, on account of their mutilated ſtate, and the probability of frequent miſinterpretations.

Sect. II. On the doctrines of Zoroaſter. The learned are divided in their opinions concerning what he taught reſpecting deity. Some imagine him the author of the ſyſtem of two principles, while others think that he amended the ancient doctrine of the Magi by teaching that there was one eternal and ſupreme being, and that Oromazes and Ahrimanius were his delegates in governing this world. Our author conceives that this laſt opinion, though maintained by ſome of thoſe who have moſt ſtudied the point, is by no means proved. Ariſtotle is the firſt Greek writer who notices the doctrine of the Magi; and though in one place he ſays that they acknowledged a good firſt author of all things, yet in another he expreſsly affirms that they held two principles, a good and a bad. To make him conſiſtent, therefore, he muſt underſtand his firſt author as being one of theſe principles, namely the good; which is the perpetual doctrine of the ancient writings, and of the Zend. Eduemus, the diſciple of Ariſtotle, ſays that the Magi taught a good deity and a demon, both ſprung from the intelligible and compound world, which ſome called time, others place. Here this firſt principle is deſcribed as void of an intelligent nature. Theopompus in Plutarch relates the opinion of a long conteſt exiſting between the two principles, to terminate in the victory of the good one, after which the human race will be pure and happy; and the good being, or Oromazes, will repoſe a while, as having no adverſary remaining. This was the ſyſtem of Zoroaſter, and only implies a ſuperiority of the good over the bad principle. The writers who ſpeak of the religion of Zoroaſter as reſtored under the Saſſanidæ, repreſent its doctrines in a ſimilar manner. The writings of the Zend itſelf, properly conſidered, repreſent no intelligent being prior or ſuperior to Oromazes; for their *Zarva* is only a perſonification of eternity. From them, the doctrine of Zoroaſter appears to have been, that there was a double principle of things, a good and a bad, the firſt called Oromazes, the latter Ahrimanius; the firſt ſymbolically repreſented as in light, the latter in darkneſs—that theſe, produced from infinity of time, or Zarva, were eternal; and therefore the evil being was not created by the good; but whether they were co-eternal, is not determined. It only appears, that Oromazes was the chief deity, the only and original author of all good things, much ſuperior to Ahrimanius, and therefore only to be worſhipped. The power of Ahrimanius, the author of all moral and phyſical evil, will one day be deſtroyed, and all the works of Oromazes be reſtored to their priſtine purity. From ſome obſcurity in the enunciation of the tenets of Zoroaſter, and the want of accurate ideas at ſo early a period, it happened that a great many different ſects aroſe, who expounded his doctrine differently. Theſe variations have chiefly turned upon the interpretation of the Zarva, or infinite time, which was ſaid to give exiſtence to Oromazes and Ahrimanius, and which ſeveral, eſpecially after the prevalence of Mahomedaniſm in thoſe regions, repreſented as a ſupreme intelligent cauſe.

With reſpect to created beings, according to Zoroaſter, there was a double ſeries of them, intellectual and corporeal, which were good or bad as generated from the good or bad principle. Oromazes firſt produced ſix immortals (Amſchaſpand) to to which Ahrimanius oppoſed as many evil geniuſes. The firſt next created 24 geniuſes of an inferior order, (Ized), preſiding over the months and days; and then an infinite number of human ſouls (Ferver). Ahrimanius on the other hand produced a great multitude of evil geniuſes. This is the double order of the intellectual world. After Oromazes had reigned alone in this world for 3000 years, he proceeded to form corporeal things, the elements, trees, animals, man, at certain intervals; and in this world, as yet pure, he reigned alone 3000 years more. In the 7th millenary, Ahrimanius, who as yet had remained with his geniuſes in darkneſs, began to infect the world. The firſt animals ſent on the earth, the primigenial bull, and man ſprung from him, being overthrown and killed by Ahrimanius, gave riſe to men, animals, and plants. From this period begins the conflict of light and darkneſs, or of the two principles, which is to continue 6000 years. For 3000 years the empire will be divided; for 3000 more Ahrimanius will be ſuperior; till the ſpace of 12000 years being completed, all evil ſhall be at an end, the dead ſhall riſe, and all things be reſtored to their priſtine purity. Oromazes is ſaid to have produced all things by his word (Honover), of which wonderful things are related in the Zend; as, that he continually meditated and pronounced it during creation; that it was prior to the elements and to bad geniuſes: a ſoul is alſo attributed to it, and prayers addreſſed to it. But this ſeems to ſignify no more than, as its name imports, the will of Oromazes in forming the world, perſonified by Zoroaſter, in order to give his religion a more divine ſanction; though from the manner in which it is ſpoken of, it is not ſurprizing that latter interpreters have regarded it as a ſubſtance.

Similar ſubtleties are entertained concerning the elements fire, water, and light, which being ſaid in the Zendic books to have acted from the beginning, it has been thought that Zoroaſter conſidered them as primigenial—a production of infinite time or the ſupreme being, of a ſublime and divine nature, containing the origin of all things—that fire was the maſculine or active principle, water the feminine or paſſive, and light a neuter proceeding from their conjunction—that from this Oromazes was formed, who created another firſt fire and water, whence geniuſes of a maſculine and feminine nature were produced. Theſe and other myſtical opinions ſeem to have no foundation in the original books, but to have proceeded from later ſophiſts. There are, indeed, in the Zendic writings extravagant praiſes of fire and water expreſſed in the mythologic ſtyle of the Eaſt; but they are every where repreſented as the gifts of Oromazes. One paſſage, indeed, adduced by Anquetil, in which fire is called the primeval agent, and the principle of union between Oromazes and eternity, ſeems to involve ſome ſublimer notion of the eternal fire.

The ſum of the religious dogmas of Zoroaſter is this: that Oromazes or the good being is the author of all that is good and pure; that he is to be worſhipped by purity of mind, ſpeech and actions, and that the good geniuſes and all elements produced by him are to be held ſacred: that Ahrimanius, on the contrary, and his works and geniuſes, are to be ſhunned, hated, and combated, in order to promote the victory of good over evil. The ſouls of good men after death will paſs over the bridge Tſchinevad to the happy ſeats of the Gods; thoſe of the wicked will be thruſt down to hell; till the courſe of ages being ended, the dead will riſe again, and Ahrimanius being entirely ſubdued, the world will be converted into a pure habitation of pure men. The Bundeheſch adds, that bad men and demons will be converted and made finally happy, which opinion however, does not well agree with the doctrines related by Plutarch and Theopompus.

With reſpect to the origin of Zoroaſter's doctrines, and the manner in which he accommodated his new religion to the notions received among his countrymen, this writer obſerves, firſt, that the fundamental principle of good and bad demons or geniuſes, is found among almoſt all rude nations, who account for all the natural appearances, the cauſes of which they are ignorant of, by its means. Light and darkneſs, too, have been from the moſt ancient times applied to denote the oppoſite qualities of purity, felicity and truth, and of impurity and miſery. Theſe original notions Zoroaſter framed into a mythological ſyſtem, in which the ſcale or gradation of deities was deduced from the form of the Aſiatic empire, adminiſtered by ſubordinate rulers over particular provinces. The twelve millenaries of years in his period of conflict between the two principles was derived from the twelve ſigns of the Zodiac. The idea of the ſeven immortals, or Amſchapands, viz. Oromazes with his ſix attendant Gods, is not ſo eaſily traced, and a variety of explanations have been given of it. On the whole, it is probable that they refer to the divine virtues, and that their number is derived from that of the planets. The other deities are taken from the elements and parts of nature. The notion of ideas or ſouls called *ferver*, attributed to all animated beings, and to Oromazes himſelf, is drawn from the opinion of the immortality and pre-exiſtence of the human ſoul; and ſeems only a tranſlation of the human nature to ſuperior beings. The primigenial bull was probably a fable adopted from the ancient religion of an agricultural people, by whom that animal was held in high veneration, and made a ſymbol of fruitfulneſs. Various other figments, as that of the divine Hom, the original author of his religion, of the demons coming from the north, of mount Albors, the navel of the world, &c. ſeem much more probably derived from ancient opinions and adopted by Zoroaſter, in order to conciliate the minds of the vulgar, than invented by him as a cover for philoſophical notions. His own peculiar doctrines appear to have been thoſe of the two principles, a future ſtate of rewards and puniſhments, the reſurrection of the dead, and the final reſtoration of all things.

XIV. *On*

XIV. *On the Coins of the Aſmonæans.* *By* Thom. Chr. Tychsen.

THE diſpute on the antiquity of the Samaritan coins is well known in the literary world. By ſome they are ſuppoſed to belong to the moſt ancient kings of Iſrael, by others to the Samaritans, by a third claſs to the Aſmonæans. On the other ſide it is ſaid, that the Hebrews did not uſe coins, and that the Hebrew letters now in uſe are the ancient character, and the inſcriptions on the coins are Samaritan. The intention of this paper is to make ſome remarks on theſe coins, which have been the cauſe of ſo much controverſy.

The coins allowed on all ſides to be genuine, are thoſe of Joannes Hyrcanus, Alexander Jannæus, and Antigonus.

I. The coins of Joannes Hyrcanus have on one ſide an inſcription, included in a crown of laurel; on the other a double cornucopia, with a poppy between. Theſe are delineated by Bayer.* No. II. III. IV. V. VI. VII. The inſcription is, יהו | חנג הנה | כוהנ הנ | שיא Jehochanan the prieſt and prince. Bayer's ſuppoſition, that הנ either belongs to the name, or is the particle הנ, will hardly be allowed, and it ſeems to be the fault of the engraver, who wrote הנ for הכ in the following word.

In No. III. firſt publiſhed by Reland,† but ill delineated, the whole cannot be read, though the name ſufficiently appears יהוחננ הכהנ ... וחברין .... The ſame name is on No. IV.

No. V. יוח ננ הכו הנ הג Jochanan the high prieſt.

No. VI. VII. are very ill delineated, but the inſcription ſeems to be,

No. VI. יהוחננ הכהן הגד ל וחבב

No. VII. יהוחננ | הכהן הגדל | וחבב

Swinton, and others, read וחבריו, and his aſſociates, Barthelemy makes out וחבב יון φιλελλην. But as the word occurs with a ר in the coins of Alexander Jannæus, the conjecture of Swinton ſeems the moſt probable.

II. Whether there are any coins of Alexander Jannæus in exiſtence is ſtill matter of doubt, but they are of two ſorts. Some like the former with this inſcription, ינתנ הכהנ הגדל וחברין ב‡ or more fully יהונתנ הכהנ הגדל וחברי.. Jonathan the high prieſt and his aſſociates.§ The ב and כ reſemble the common forms, and prove that the preſent mode of writing was then in uſe.

The inſcriptions of the other coins are in two languages. On the one ſide is a wheel, with the words βασιλεως Αλεξανδρȣ.** Barthelemy ſaw in ſeveral Samaritan letters, with the name of Jonathan; and in his third letter to the editors of the Journal des ſçavans, one is deſcribed with the inſcription יהונתנ המלך on one ſide, and βασιλεως Αλεξανδρȣ on the other. According to Barthelemy, this Alexander was king of Syria, ſurnamed Balam, the ſucceſſor of Demetrius Soter, and Jonathan the ſon of Matathias, predeceſſor of Simon. But as this Jonathan never bore the title of king, which was firſt aſſumed, according to Joſephus,†† by Judas Ariſtobulus, or according to Strabo,‡‡ by his ſucceſſor Alexander Jannæus, it is clear that the coin muſt belong to one of them, or to one of the Aſmonæan family. As there was not any king of Syria after Alexander the Second, the cotemporary of John Hyrcanus,

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* De numis Hebr. Sam. p. 190.

† Diſſ. de Num. Heb. ad p. 119, apud Hauberum Nachricht von den jüdiſcher Münzen, No. 27.

‡ Mem de l'ac des Inſcr. T. XXIV. p. 60.

§ Bayer. p. 190, No. 1. Hauber. No. 26.

** Reland. p. 6. diſſ. de N. Hebr. Frælichius. Ann. Reg. Syriæ. Tab. IX. 35.

†† Ant. XIII. 11.

‡‡ L. XVI. c. 17.

canus, by the name of Alexander, this name muſt refer to a king of Judea, who inſcribed on the coin both his Greek and Hebrew name. This king muſt have been Alexander Jannæus; for, though it is not certain that his name was alſo Jonathan, it is well known that the Jews had at that time very commonly a double name. Thus, in the Aſmonæan family, Ariſtobulus was called Judas, and Alexandra, Salome.* It is to be obſerved here, that the coins having a vine-ſtalk with a bunch of grapes, and an urn, ſuppoſed to be thoſe of Alexander Jannæus, belong to Herod or Philip.†

III. The coins of Antigonus, the ſon of Ariſtobulus, have on one ſide a laurel crown, with the inſcription on the margin, or ſurface, *βασιλεως Αντιγονου*; on the other ſide a cornucopia, with a pendant band, or a double cornucopia, as in the coins already deſcribed, with an inſcription around in Samaritan letters, in which may be traced the words מתתיה כהנ זדל ח.‡ As this Antigonus was the only one of the name who bore the titles of prieſt and king, the coins can be referred to him alone.

Theſe coins bear a great reſemblance to thoſe of the Seleucidæ. The cornucopia is ſeen in the coins of Demetrius Soter, and Nicator, and the poppy in thoſe of Cleopatra.** Hence it appears that the Jews imitated the Syrians in their coinage, and the coins of Phœnicia prove that double inſcriptions were uſed by the ſurrounding nations.

If the ſtatement above is allowed, the argument that the Jews never coined money, and that theſe ſuppoſed to belong to Simon are forgeries of later times, falls to the ground; and as the neareſt ſucceſſors of Simon coined, it it probable that he made uſe of the ſame privilege.

The other objection, that the letters in the ſhekels and coins of Simon are not ancient Hebrew characters, but taken from the alphabets of Theſeus and Poſtellus, is alſo of no weight, ſince we have here coins of the ſame family, and with letters of a ſimilar character.

Little can be deduced from the hiſtorical teſtimonies in this diſpute on the coins of Simon. It ſeems clear from the noted place in Maccabees,†† that the power of coining money was granted to Simon, and the authority of the Syriac verſion cannot be produced againſt it, ſince the learned allow, that the Syriac verſion was taken from this Greek text, and from miſunderſtanding the Greek words a different ſenſe was extracted. But, without dwelling on this text, whether the right of coining was then firſt granted or confirmed to Simon, it is probable that he made uſe of the privilege.

On the teſtimony of Joſephus, *ὁ δε σικλος νομισμα Εβραιων ων αττικας δεχεται δραχμας τεσσαρας*, it may be obſerved that *νομισμα* can refer only to coinage.‡‡ Joſephus errs in comparing this coin with the attic tetradrachm, ſince he is ſpeaking of the Moſaical age, in which there were not any coins: but it was natural for him to uſe the language of his own times, in which the poll-tax was paid in coined ſhekels; and all that can be gathered from this place is, that in the time of Joſephus there was a Jewiſh coin equal to the attic tetradrachm.

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[*] Joſ. Ant. XX. 10. XIII. 12. Mem. de l'ac. des inſer. T. XXIV. p. 60.

[†] Bayer. c. IX. Bouteroue. Recherch. ſur quelq. medail. p. 24.

[‡] Frölich Ann. reg. Syr. Tab. II. 3. Reland. Diſſ. V. p. 183. Barthelem. p. 52. Hauber. No. 30. 31. 32. Pellerin. Suppl. Tom. IV. p. 119. מתתיה הכהנ ה. in Com. T. VIII. p. 128.

[**] Frölich Tab. VIII. 22. X. 2. XII. 13. 14. 16. X. 18. 19. XI. 1. 23. XII. 4. XIII. 1.

[††] 1. Macc. XV. 6.

[‡‡] Antiq. III. c. 8. § 2.

But there is no need of hiſtorical arguments; the antiquity and credit of ſcarce any other ancient coins are better eſtabliſhed. In the thirteenth century, Moſes Nachmanides mentions a ſhekel ſeen by him at Acco, in Paleſtine, at a time when there was not any ſearch made after Jewiſh coins. Many were alſo brought out of the Eaſt. Poſtellus declares, that ſimilar coins were frequently dug out of the ruins of Jeruſalem. The Wildian coins, deſcribed by Reland, were brought out of Syria, and not ſold for the ſake of gain: the two ſilver, and three gold ones, of Bayer, were brought either from Jeruſalem or Paleſtine. Elias Scheidiacus brought three gold ones from Aleppo.* It is abſurd, therefore, to ſuppoſe that they were all forged in Italy, unleſs we can imagine that the artiſts ſent their workmanſhip into the Eaſt, to be brought back and ſold at a low price in Europe.

Beſides, theſe coins, which have the marks of antiquity, are very ſcarce. Bayer poſſeſſed only forty, gained from the collections of his numerous friends; and in the ample repoſitory of the king of France there are only eighty. In Germany, Samaritan coins abound, but they are in general ſpurious.

But the appearance of the coins proves their antiquity. They are ſtamped, not caſt; the inſcriptions and ſymbols agree with the age and manners of the nation. The letters are not like the Samaritan character in books, nor like thoſe of the Phœnician coins, but though more ſimple, like thoſe in the coins of the later Aſmonæans. The ſymbols, though to be found in the coins of the Seleucidæ, agree with the fertility of Paleſtine, the ſacred rites, and hiſtory of the nation. The coins of Antiochus the Great have the palm, thoſe of Antiochus Epiphanus the vaſe; thoſe of Seleucus IV. the lyre.

From theſe arguments, and the authority of Spanheim, Reland, Bayer and Barthelemy, who had ſeen the genuine coins of Simon, we may ſafely affirm that there are coins of Simon, with the genuine marks of antiquity on them. The difficulties from the chronology, the variety of characters or weight, cannot deſtroy their authenticity, ſince they are common to other coins, and a proof that they could not come from the magazine of a ſingle forger. As to the ſilence of writers, though it appears clear, that Joſephus refers to theſe coins, the ſame argument would at one blow deſtroy almoſt all our ancient coins.

But it muſt be allowed, that many coins going under the name of Simon, are ſpurious, and perhaps, ſince the credit of the Hebrew ſhekel was eſtabliſhed by Poſtillus and Arias Montanus, there have been more forgeries in this than any other branch of ancient coinage. Some have modern Hebrew characters, being firſt caſt and then worked with a graving tool. They are to be found every where, being chiefly of ſilver, of conſiderable dimenſions, and very much alike. Theſe were forged by Jews, as were alſo the coins bearing the names of Moſes, David, and Abraham, taking from the Talmud, though the inſcriptions דוד ושלמה and עיר קודש ירושלם ſaid to exiſt in the coins of David, might belong to the ſhekels.‡

Another numerous claſs of ſpurious coins has Samaritan inſcriptions, ſome reſembling the genuine ones ſo as to deceive the inexperienced, others betray the fraud by the unſkilful manner in which they were caſt. Hence it is probable that ſome were forged for the ſake of gain, others were copies taken for the uſe of the learned.§

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* De numis Hebræo-Sam. 47. & Vindic. p. 33. 39.

† Frölich Tab. VI. 16. T. XII. 13. XIII. 35. XI. 12. Tab. VI. 4.

‡ Baba Kama. fol. 97. Wagenſeil ad Sota, p. 574.

§ Curieuſe Biblioth. T. II. p. 356.

Theſe coins from the ſcarcity of genuine ones are the moſt common in Germany, and hence it is not to be wondered at that Schlaeger, and others, who had never ſeen any genuine Samaritan coins, ſhould conſider them all as ſpurious; and Bayer runs into the other extreme, in affirming that he never met with a ſpurious coin, having Samaritan characters; but he afterwards ſilently retracts this error, by mentioning two ſpurious ones. ‡

A particular claſs of Jewiſh coins is made from the reſtamped ſilver denarii of Trajan, on which is a character ſimilar to that of the Aſmonœan coins, though there are traces of the Roman inſcription and imperial figure ſtill viſible. On the one ſide is a bunch of grapes with the remains of the name שמעון; on the other ſide a lyre or a palm tree or two pillars, with the letters לחרות ירושלם, for the deliverance of Jeruſalem. Henrion § firſt mentioned this coin, Woide ¶ deſcribes two in Hunter's collection, and Barthelemy, a fourth in the letter already quoted.

From theſe coins Henrion has framed the ſtrange hypotheſis, that all the Samaritan coins having the name of Simon, belong to Simon Barchochebas. Barthelemy ſupports this opinion. 1ſt. Becauſe the coins being reſtamped muſt be later than the time of Trajan. 2. Barchochebas gave liberty to Jeruſalem. 3. He coined money. But againſt theſe arguments it may be urged, that Barchochebas does not appear to have had the name of Simon. It is doubtful whether he coined money, and Scaliger's aſſertion, Verum ejus nomen כוזבא and כוזב quomodo vocata eſt pecunia ejus nomine cuſa, is gratuitous.‖ Laſtly, it is not true that Jeruſalem was delivered by Barchochebas, for Jeruſalem was deſtroyed before his rebellion, the Jews were entirely baniſhed from the new city Ælia Capitolina, and Bitthera not Jeruſalem was the ſeat of the war.

Barthelemy however ſuppoſes, that the coins attributed to Simon are of two ſorts, the more elegant are to be referred to Simon Macchabæus, the others with inverted and deformed letters belong to the age of Barchocab, in whoſe time the artiſts were not ſo well acquainted with the ancient Samaritan letter. But why ſhould Simon at the beginning of the Jewiſh coinage have the moſt elegant coins? It is extraordinary, that the coins of Trajan are the only ones reſtamped with a Jewiſh character: but we may beſt account for this, perhaps, by ſuppoſing that as theſe coins are very numerous, ſome forger uſed them in preference to any others.

XV. *A Diſquiſition whether the origin of the Ruſſians, Poles, and other Sclavonian Nations can be deduced from the Getæ, or Dacians. By* J. Christ. Gatterer.

THE origin of the Slaves or Sclavonians is a ſubject buried in deep obſcurity. It can ſcarcely be doubted that they were a people indigenous to Europe, in the ſame ſenſe in which all the other principal nations of Europe are reckoned ſo. Their name indeed appears in no writer before the ſixth century, but it might lie concealed under a foreign appellation, as that of many others has done. Jornandes who firſt mentions them, ſays that they fell under the dominion of Ermanaric king of the Goths between A. D. 335 and 368. This king poſſeſſed all Sarmatia and Dacia; in one of theſe countries, therefore, the Sclavonian nation muſt have lain concealed:

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‡ De num Sam. p. 51. Vindic. p. 49.

§ Memoires de l'Academie des inſcr. T. III. p. 198.

¶ App. ad Bayerium de num. Hebr. Sam.

‖ Ad Euſebii Chronicon. p. 216.

It is among the Dacians, whoſe country lay between the Teiſs and Dnieſter, that this writer makes his ſearch. From paſſages of Jornandes and Procopius, he draws the following facts. 1. The whole nation of Slavi was in the 6th century divided into two tribes, the Sclaveni and Antæ, or into three, if the Venedi or Winidæ are to be accounted as ſeparate from the Sclaveni. 2. The Sclaveni properly ſo called inhabited from the eaſtern limit of Pannonia to the Dnieſter. To the ſouth they approached the Danube, but did not reach it. To the north they were bounded by the Carpathian chain. 3. The Venedi, a very numerous tribe, inhabited a vaſt tract from the northern ſide of the Carpathian chain to the ſource of the Viſtula. 4. The Antæ were incloſed between the rivers Dnieſter and Dnieper, extending northwards towards the Euxine Sea. The writer now propoſes, as his ſubject, to enquire, whether the Getæ or Dacians of theſe times poſſeſſed the very ſame ſettlements with the Slavi, and were only diſtinguiſhed from them by name? For this purpoſe he thinks it neceſſary to trace the hiſtory of thoſe people from the time of Herodotus through all ſucceeding ages, and in all places. We do not think it requiſite for us to accompany him cloſely in this progreſs through the works of well known hiſtorians. It will be ſufficient to point out the chief reſults.

The Getæ, firſt known as inhabitants of the northern parts of Thrace, fell, with the reſt of the Thracians, under the dominion of the Perſian kings from A. M. 3476 to 3514, and afterwards became ſubject to the Odryſian empire, to about 3560, or B. C. 423. At the time of Alexander they had changed their ſeats from the northern part of Thrace, to the oppoſite ſide of the Danube, or weſtern Scythia, and were an independent nation. They underwent a ſlight attack from Alexander, and a more ſerious one from his ſucceſſor Lyſimachus, who was defeated and taken priſoner by the Getic king Dromichætes. About this time the Triballi, a kindred people, fled acroſs the Danube to the Getæ, and loſt their name in that of the Dacians. Theſe henceforth made one nation. The Getic empire roſe to its height of power in the century before Chriſt, under king Bærebiſtas, who ſubdued many of the neighbouring nations, and croſſing the Danube, became formidable even to the Romans. But this ſtate did not laſt long, for the king being killed in a ſedition about B. C. 32, the empire was divided between ſeveral reguli. From Strabo and Pliny it appears that the limits of the country of the Getæ, or Dacia, were the Danube to the ſouth, the Carpathian mountains to the north, and the Dnieſter, or ſomething beyond it, to the eaſt. As to the weſtern boundary, it appears in Strabo's time to have extended to the country of the Suevi, or the river March, but in Pliny's time the Sarmatian Iazyges occupied part of the tract between that river and the Teiſs.

Conteſts between the Romans and Getæ enſued with various ſucceſs for a century, till in A. C. 106, Dacia by the victories of Trajan was made a Roman province. This province, however, did not comprehend above one third of the country of the Getæ, the northern, eaſtern and mountainous parts being left to them. If it be enquired what became of the ancient inhabitants, there is no reaſon to doubt that for the moſt part they remained upon the ſame ſpot, as well thoſe of the Roman Dacia, as of the reſt of the Getic country. Under the ſucceſſors of Trajan many wars were waged for the preſervation of Dacia with various event. In the reign of Caracalla, the Goths ſeem to have acquired a fixed ſeat among the Daco-Getæ; for henceforth the names of Goths and Getæ are uſed promiſcuouſly. Under Gallienus, by the irruption of the barbarous nations, Dacia was loſt to the Romans; and Aurelian entirely relinquiſhed the province, withdrawing his army and the provincials into Mæſia. This was about the year 274. To this period the Daco-Getic nation ſeems to have remained ſafe and entire in Dacia; and during the reign of Aurelian, Dacians ſerved in the Roman army. This emperor, being unable to keep the province, left it to its new occupiers, the Goths, without carrying away the indigenous inhabitants. From 274 to 335 Dacia was ſubject to the Goths, eſpecially the Viſigoths; afterwards it came under the dominion of the Oſtrogoths, whoſe king was Ermanaric. From this time the ancient names of Getæ and Dacians were changed for Antæ and Sclavi; but how this change happened we are ignorant. The name of Antæ ſoon became obſolete, and for Sclavi or Sclaveni the ſofter appellation of Slavi and Slaveni was introduced by themſelves. On the irruption of the Huns into Europe, the Slavi were conquered by that people, but ſtill allowed to have a king of their own. At the death of Attila in 453, they recovered their independence. This was retained by the northern Slavi, or the Venedi, who at this period had emigrated nearer to the Baltic Sea; but the oriental Slavi, or Antæ, fell under the power of the Kutriguri, or Ungrians from about 472 to 561, at which time they, with their maſters, were ſubdued by the Avares. Part of the weſtern Slavi alſo came under their dominion. In 603 we find the eaſtern Slavi in alliance with the Byzantines, the weſtern with the Avares. The eaſtern or Antæ were, however, ſo ill treated by the Chacan of the Avares in revenge for injuries offered to his allies, that their name is thenceforth no longer heard of. Probably they migrated to ſome parts of the country more remote from the Black Sea. The weſtern Slavi were alſo, about 635, compelled to leave their native ſeats. At this time we are told that Cubrat lord of the Unnogunduri, rebelling againſt the Chacan, expelled the *whole people* which he had received from him, from their paternal habitations, after contumelioſly treating them. This *whole people*, our author conjectures to have been the weſtern Daco-Getæ, or Slavi; and the Bulgarians to have been the nation whoſe lord thus expelled them.

After this hiſtorical deduction, he leaves the reader to determine for himſelf "whether the origin of the Sclavonians can be derived from the Getæ," further obſerving, that from the relics of the Getic language it appears to have had a greater reſemblance to the Sclavonian than to any other.

XVI. *On the Origin of Greek Literature among the Arabians.* *By* J. GOTTLIEB BUHLE.

THE preparing of a new edition of Ariſtotle, having turned the attention of this writer to the Arabian commentators, he was led to examine the queſtion, whether the Arabians, who are known to have derived moſt of their knowledge from Greek ſources, obtained it directly from the Greeks, or by means of Syriac and Arabian verſions.

Before Mohammed and for the two firſt centuries after the Hegira, the Arabians were but little addicted to literature. The only ſpecies cultivated by them was poetry chiefly of the lyric kind, and this has given a great richneſs to their language; but the little they knew of aſtronomy is chiefly to be attributed to the obſervations of a paſtoral life, or ſome trite maxims of aſtrology. The reading of the Koran, for ſome time after Mahomet, entirely occupied their attention, and they had no leiſure for ſtudy or indeed for any thing elſe but war and rapine.

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The firſt ſeeds of erudition were ſown in the time of Merwan II. Heg. 133. the laſt of the Ommiades, who was ſucceeded by the Abbaſſides or Haſchemides. This was done chiefly by Jews and Chriſtians, who though in general occupied in trade, had amongſt them ſome few capable of reading and tranſlating Greek. Sergius had in the time of Juſtinian tranſlated ſome books of Hippocrates into Syriac, and the Chriſtian phyſicians were in particular eſteem in the Arabian courts.* Theſe derived their knowledge of phyſic from the Greeks, and for the better underſtanding of their art, they were obliged to ſtudy their philoſophical as well as medical writings. Hence the names of Ariſtotle and Plato were as well known to the Arabians, as thoſe of Hippocrates and Galen. As the Arabians were fond of aſtronomy, it is not to be wondered that ſome of the Chriſtians ſhould introduce among them the diſcoveries of Euclid, Eratoſthenes, Ptolemy, Aratus, and Apollonius of Perga.

But it does not appear that the Greek language was much cultivated by the Arabians, and the rewards propoſed by Al Manſor, for the tranſlation of Greek books on medicine, philoſophy, and aſtronomy had no other effect than to excite ſome Syrians to tranſlate their books on theſe ſubjects into Arabic. Thus the firſt Greek authors were known to the Arabians from Syriac verſions, but none of thoſe made by order of Al Manſor are at preſent in exiſtence. We have not any thing certain on the verſions of Bochtjeſu, and thoſe of Sergius were very imperfect and full of errors, ſo that a new Syriac verſion of Hippocrates was afterwards undertaken by Honain ben Iſaac.

During the reigns of Al Mamun and Al Motawachel. (Heg 218 to 247) the learning of the Greeks was expanded by a number of men collected together, by order of the former Chaliph on the advice of John Meſueh, who ſuperintended the tranſlation into Arabic of a vaſt variety of books on medicine, natural hiſtory, philoſophy, coſmography, and mathematics.† The Chaliph demanded the chief works from the emperor Michael Balbus, and purchaſed others in Syria, Armenia and Egypt. Theſe verſions have alſo been ſuperſeded by thoſe made by the Honains and Geuzi relates a circumſtance not improbable of the originals, that, as ſoon as the verſions were made, the Greek books were deſtroyed by order of Al Mamun. This might have been either in compliance with popular prejudice or to give the Arabians, by deſtroying the fame of the Greeks, the whole credit for literature. We hear of no more Greek copies amongſt the Arabians after the time of Meſueh and his diſciples, and theſe, who paſſed over into Spain or Sicily, carried with them only Syriac or Arabic verſions.

Of all the interpreters under the auſpices of Meſueh or afterwards, the Honains were the moſt illuſtrious. Honain ben Iſaac, a Chriſtian Ebadianite, was born at Hira. Having received ſome provocation from Meſueh, he travelled into Greece, and employed himſelf there two years, engaged particularly in the ſtudy of the language. Returning from thence with a great number of books, particularly the works of Ariſtotle, Euclid, Ptolemy, Galen, Alexander, Aphrodiſius, Porphyry, Themiſtius, and Simplicius, he learned the Arabic language at Baſſora, and afterwards

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* Agathias de reb geſtis ſub Juſtiniani Imp. 141. Ed. Par. Abulpharaj. hiſt. dynaſt. 94. Aſſemani. bib. or. T. II. 272. 273. Renaudot. Ep. ad. Dacerium. ap. Fabric. B. G. Vol. I. p. 861.

† Eutychii Alexandr. Annal. T. II. p. 407. Elmacin. hiſt. Sarac. L. II. c. 6. Leo Africanus. de claris et illuſtribus medicis. apud Arabes.

wards employed himſelf at Bagdad in the time of El Motawachel in Syriac and Arabic verſions. He ſeems to have ſucceeded to the place of Meſueh, being firſt phyſician to the Chaliph, and ſuperintending and correcting the verſions of his ſons Iſaac and David, as well as his ſiſter's ſon Hobaiſh bar Haſan, Georgius ben Bochtjeſu, and Bochtjeſu ben Gabriel: and hence, as very many verſions go under his name, it is difficult to tell by whom they were made, whether by himſelf or his aſſiſtants. To the father are attributed the verſions of Hippocrates, Galen, Almageſt of Ptolemy and Nicolas Damaſcenus on the Ariſtotelian philoſophy, bu ttheſe were Syriac, and afterwards tranſlated into Arabic by his ſons or others.* The verſions were firſt made into Syriac, and from thence into Arabic, and the ſubſequent verſions of Thabet ben Cora, Ebn al Batrick, Abu Baſchar Mata, Jahia ben Adi, Abraham Abdallah, proceed for the moſt part from the tranſlations of the Honains: and the celebrated tranſlation of Ariſtotle by Averrhoes of Cordova was made in the ſame manner, as he does not ſeem to have had the Greek text before him, and he only corrected the common Arabic verſion of his time, by a compariſon of it with the old Syriac tranſlation.

Both the ancient and more modern Arabic verſions are full of errors, from which for want of Greek copies they could not by all the ſtudy of the Arabians in Spain and Sicily be freed. Many of them are loſt, ſome hid in libraries, but from thoſe printed the truth of the aſſertion juſt made it evident. Some of them have been tranſlated by the Rabbins into Hebrew. There is at Vienna the Organum of Ariſtotle tranſlated from the Arabic of Averrhoes by R. Jac Antoli A. 1232, or by the Jewiſh æra 4992, under Frederick II. in the library at Paris a tranſlation of the Phyſica of Ariſtotle by R. Aben Tybbon and others of the ethicks and æconomicks from the Arabic of Averrhoes, the former by R. Meir Alvarey, the latter by Aben Tybbon. From theſe Hebrew verſions came the Latin uſed by the firſt ſcholaſtics, by Albertus Magnus and Thomas Aquinas. Faulty and barbarous as theſe are in themſelves, much is be attributed to the ignorance of Averrhoes in the Greek language, who miſtakes Protagoras for Pythagoras, Democritus for Cratylus, Hercules for Heraclitus, and ſimilar errors are to be found in other Arabic verſions. Thus in the tables of Cebes, the adjuration, ὦ Ἡραϰλεις, was taken for the name of the old man ſpoken to, and at the end of the book we find the words, explicit expoſitio Herculis Socratici ad Cebetem Platonicum.

Hence we eaſily ſee why the Arabians derived ſo little knowledge of philoſophy from the writings of the Greeks. In medicine, natural hiſtory, mathematics, and aſtronomy, the ſubjects themſelves prevented them from falling into groſs errors, but collecting their philoſophy from ſcattered fragments of Ariſtotle, and his commentators, they confounded together the ſyſtems of the old ſchools, and were ſtudious only to reconcile an opinion with the ſcattered doctrine of Plato and Ariſtotle. With the philoſophy of Socrates they ſeem to have been unacquainted, and not to have read the memorabilia of Xenophon, or the dialogues of Æſchines, and the doctrine of Plato was not known in the weſtern part of Europe, till his writings brought from Greece into Italy had made their appearance. Perhaps when Greek literature was firſt cultivated by the Arabians, the works of Plato were leſs ſtudied than thoſe of the Stagiryte, and Honain ben Iſaac may by accident have collected more of the writings of the latter, than of any other author. Thus all their philoſophy borrowed from Ariſtotle, and encumbered not only by the difficulties in the author himſelf, but the errors of the verſion, was employed more on tricks and ſubtlety, than true knowledge. They certainly did not want the ardour of reſearch or the patient labour of ſtudy, but the miſt was not to be penetrated; and beſides the embarraſſments thrown in their way by the doctrines of the Koran were unſurmountable.

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* Aſſeman. bib. or. T. II. p. 272. 310. 311. Caſiri. bib. ar. hiſp. T. I. 306.

The hiſtorians and poets of the Greeks were either not known or not eſteemed. There is no mention made of any Greek hiſtorian, except of ſome who wrote an account of Alexander's expedition in Aſia; and from many of their relations of facts in the Grecian hiſtory, it is clear that they were entirely ignorant of them. They had heard nothing of Homer, are ſilent on the lyric, tragic and comic poets, but tranſlated ſome of the didactic poems, as in the Pariſian library is a verſion of the phænomena of Aratus. Probably the ſtile of Grecian hiſtory and poetry was not pleaſing to their taſte.

It remains only to conſider what profit may be derived from a collation of the Arabic verſions with the Greek text, and as they gave a literal tranſlation and had older copies than any now in exiſtence, it is evident many corrupted places in the Greek text may by their means be reſtored. As the books of the old and new teſtament have been rectified by the Arabic verſions, and Ariſtotle has been reſtored by the Latin verſions from Averrhoes, the ſame advantages may be derived in other inſtances; but confidence is not to be placed in the tranſlator, except in ſingle words, of which he clearly appears to have underſtood the force and meaning.

XVII. *A Commentary on the Attempts of the Greek Philoſophers before Ariſtotle in inventing and perfecting the Art of Logic.* By J. Gottl. Buhle.

THIS writer obſerves, that men muſt have exerciſed their reaſon on various ſubjects before they diſcovered that there was ſuch a thing as an *art of reaſoning*; and that the logical art would not be cultivated till philoſophers began to want arguments to defend their own opinions and confute that of their opponents. In the philoſophy of Pythagoras and his older diſciples, no traces of dialectics properly ſo called can be found. Archytas the Tarentine, indeed, ſeems to have treated ſome points of logic, which after writers made uſe of. It is to the Eleatic ſchool, by the unanimous conſent of the ancients, that the invention of logic is to be aſcribed, but whether Parmenides or Zeno was its firſt author is diſputed. The latter, however, was celebrated as the great dialectician, and gave riſe to a multiplicity of idle ſubtleties.

We think it unnecceſſary to accompany the writer of this memoir through his ſketch of the logical and ſophiſtical doctrines of the Greek philoſophers. In a leſs compaſs than that which he has allotted to it, the ſubject would not be intelligible; and the learned reader may have acceſs to information on theſe points from various other ſources. His concluſion, as it reſpects Ariſtotle, is, that the predeceſſors and cotemporaries of that philoſopher had with great ſucceſs cultivated almoſt all the parts of logical doctrine, at the time he compoſed his Organon:—that, however the Stagyrite is entitled to the praiſe of reducing the indigeſted body of its precepts to fixed principles, of circumſcribing the whole art within its proper limits, and of ſettling dialectical and ſophiſtical diſputes as far as could be done;—in all which he has ſhown a great extent and profundity of genius.

XVIII. *On the Gymnaſtic Exerciſes of the Greeks.* *By* C. MEINERS.

THE utility of gymnaſtic exerciſes was the ſubject of much controverſy among the ancients, and it is the intention of this paper to demonſtrate how far they are deſerving of praiſe or cenſure. [*] In the time of Homer princes exerciſed themſelves in wreſtling, boxing, running, leaping, and throwing quoits, and as beſides ſtrength ſkill was required, they were moſt probably brought up to theſe arts by proper maſters. [†] Hence the lower claſs was reſtrained from theſe exerciſes, which like arms and muſic were numbered among the liberal arts. [‡] The moſt celebrated warriors were ſkilled in them, and did not like ſubſequent wreſtlers confine themſelves only to one ſpecies: the rewards propoſed were beautiful ſlaves, oxen, horſes, mules, gold and ſilver flaggons, and ſimilar things of great value. In thoſe times there were no Gymnaſiums, but the meeting was in the forum or any ſpacious place. [§]

The confuſion that reigned in Greece for ſome time after the Trojan war, ſeems to have put a ſtop to theſe exerciſes, for all the writers, and particular Plato and Ariſtotle ſpeak of the Cretans and Spartans as the inventors in ſome meaſure of the gymnaſtic arts. Not long ago, ſays Plato, to be a ſpectator of naked exerciſes appeared as ridiculous and indecent to the Greeks, as it does now to moſt of the barbarians. According to Ariſtotle, the Spartans were for a long time ſuperior to the other Greeks, but when other ſtates had introduced Gymnaſiums, the Spartans were eaſily beat by their rivals and imitators. [‖]

That theſe exerciſes were for ſome time after the Trojan war neglected, appears probable, from the inſtitution of rewards for the ſeveral ſpecies at different times. Prizes were given firſt to the runners about the begining of the Olympiads; to the wreſtlers in the eighteenth, and to the boxers in the twenty third Olympiad. [¶] The pancratiaſtic art, conſiſting of wreſtling and boxing, was rewarded much later; [**] but neither this art nor that of boxing was permitted among the Spartans, not becauſe one of the parties muſt confeſs himſelf [††] conquered, but on account of the danger of being maimed and disfigured. In deteſtation of theſe arts, Ariſtotle praiſes the Spartans, for not encouraging an athletic habit of body among their young men. It was an enquiry among the Greeks, why Homer ſhould place boxing firſt, then wreſtling, and running laſt, ſince the two latter are the moſt ancient, and the Greeks were always of opinion, that wreſtling was the moſt difficult exerciſe, and required the greateſt ſkill. [‡‡]

Soon after the inſtitution of ſolemn games, gymnaſtic exerciſes were encouraged throughout all Greece, and the combatants had other incitements, beſides the prizes held out for the reward of each trial of their ſkill. Gymnaſiums were erected in, and were the principal ornaments of moſt of the towns of Greece; and thoſe, who had conquered at the Olympick or other games, were rewarded as much as the defenders of their country; they were freed from publick burdens, and were fed at the public expence, or received annual penſions. Solon endeavoured to bring theſe expences within due bounds, but it has been obſerved by Petit and Menage, that conquering athletics had ſoon after the time of Solon a place in the Prytaneum. Their return from the games was celebrated with great pomp, and Cicero declares that to conquer in the Olympick games was eſteemed by the Greeks, an honour almoſt ſuperior to a triumph at Rome.

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[*] Vid. Petri Fabri Agoniſticon. Lugd. 1595. 4. Hieronymi Mercurialis Com de arte gymn. Amſtel. 1672. 4. and Voyages d'Anacharſe. I. p. 351.

[†] Il. XIII. 258. Odyſſ. VIII. 100.

[‡] Odyſſ. VIII. 159. XIII. 665

[§] Odyſſ. VIII. 148. 205. Il. XXIII. 631. Odyſſ. VIII. 109.

[‖] VIII. 4. Polit.

[¶] Fab. agon. 203. 204. 343.

[**] Plut. Symp. II. 4.

[††] Senec. L. V. c. 3.

[‡‡] Plut. Symp. II. 5.

From ſuch attention paid to wreſtlers and boxers, the minds of the Greeks grew naturally depraved, and inſtead of exerciſing themſelves to become a hardier, ſtronger and more noble race, they thought only of throwing down an adverſary and gaining a prize. The people ſat whole days in viewing their games, the finances of the ſtate were ruined, in providing for them, and military virtue and patriotiſm gradually declined. *

Galen affirms that the gymnaſtic arts ſprang up not long before Plato, but from the laws of Solon and the teſtimony of the moſt ancient writers, it appears, that the dangerous conſequences of them had been much longer foreſeen. Hippocrates, Euripides, Plato, Ariſtotle, Galen, inveigh ſeverely againſt theſe exerciſes, and as the four former were ſo well acquainted with their pernicious effects, they muſt have been a conſiderable time before them in exiſtence.

Galen was their bittereſt enemy: much as he commends moderate exerciſes to give agility, ſtrength and beauty to the body, courage and fortitude to the mind, he complains that the gymnaſtic exerciſes deſtroyed the ſtrength of both, and rendered men unfit for either war or peace. Not only youth of a ſtrong conſtitution were diſciplined in the Gymnaſium, but even thoſe of a delicate frame, and boys: and hence they grew diſtorted, frequently were oppreſſed with diſorders, or carried away by a premature old age. †

Their manner of life neceſſarily weakened the human frame. ‡ As the great thing was to throw down an adverſary or bear the ſevereſt blows, their care was to give an immenſe ſize to the body. According to the precept of Hippocrates, every thing ſhould be taken in moderation, but this rule was entirely violated by theſe wreſtlers. They were accuſtomed to devour fleſh, particularly ſwine's fleſh in immenſe quantities, and then uſed immoderate exerciſes for ſeveral days together, not interrupted by any ſort of weather. The hours for ſleep and labour were entirely inverted by them, and ſometimes like brutes they ſlept for ſeveral days and nights together. To gain great ſtrength and bulk neceſſary for the prize, both body and mind were ſo impaired, that Galen declares none of them retained their ſtrength above five years, and compares them to walls, which, having been often ſhaken by warlike machines, fall down afterwards on a very ſlight attack. The changes of the weather they were as little able to bear as young children. They were ſubject to apoplexy, burſting of blood veſſels, nervous diſorders, the ſudden loſs of eyes, teeth and ſpeech. The faireſt figure fattened in a Gymnaſium became a monſtrous lump of fleſh. According to the exerciſes uſed, the limbs were impaired. The legs of the runners grew clumſy, and their ſhoulders ſmall. The arms of the boxers ſtuffed with fat and their legs ſmall. The pancratiaſtæ from the blows of the cœſtus could not be looked upon without horror, and Galen properly remarks, that it is better to dig, plow, carry burdens, reap, ride, fight, doing all theſe things in moderation, than to have any concern with boxing and wreſtling.

In

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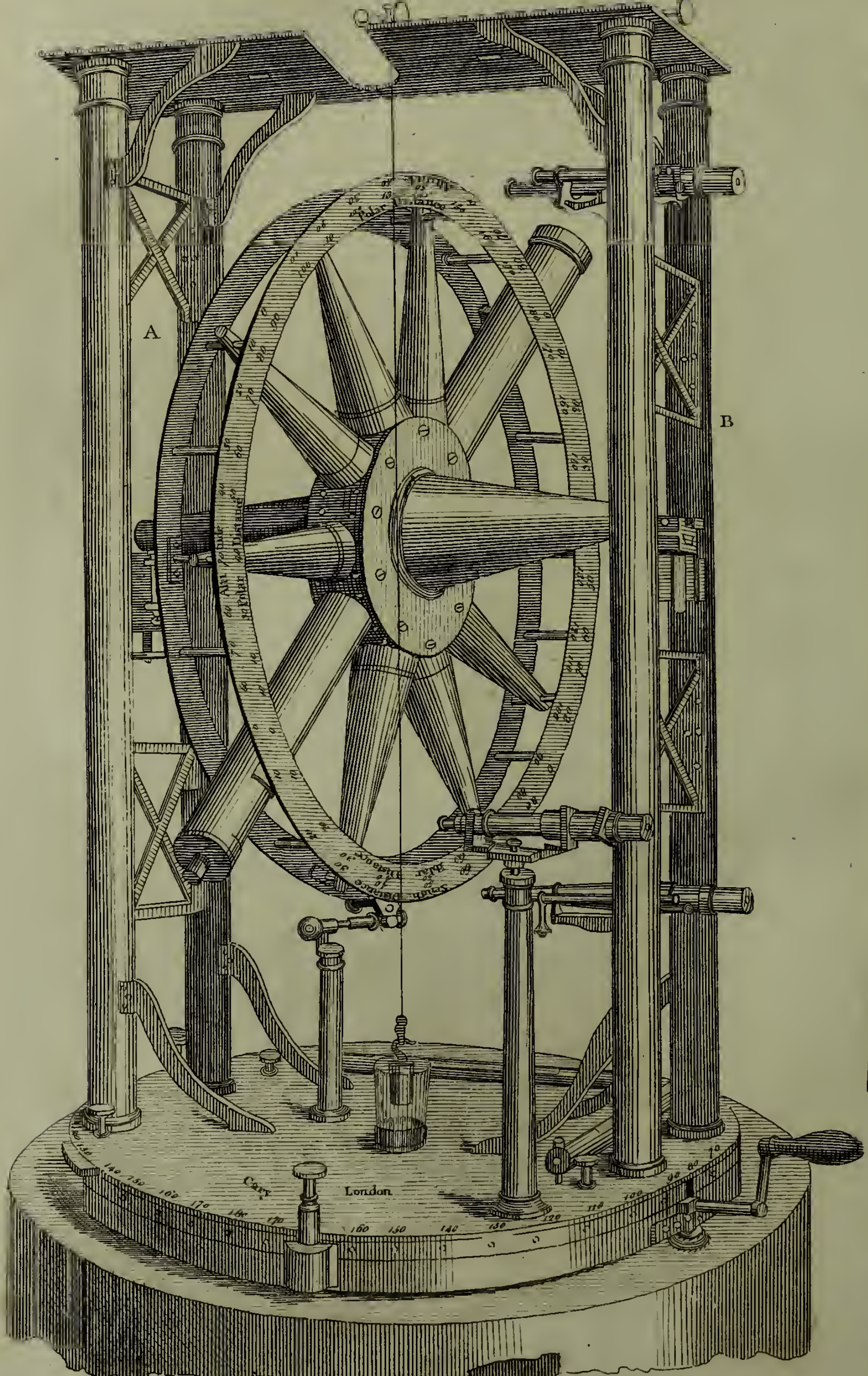
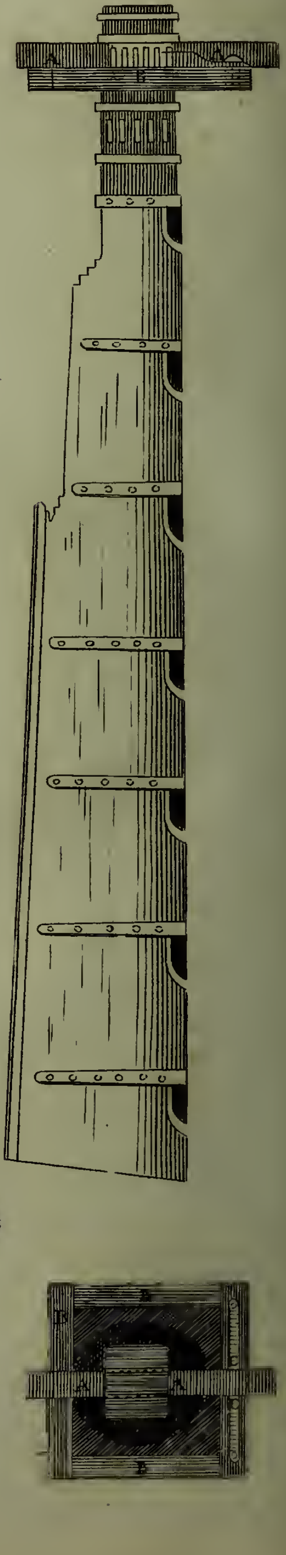
* Nub. Ariſt. 985—1054. † Oper. Hippoc. et Galen. Ed. Par. Tom. VI. ad Thraſyb. c. 36. 37.
‡ VIII. 4. 45.



A Plan by Capt. Edwd. Pakenham. to prevent a Ship's Rudder being lost.



In Plato's time theſe combatants were looked upon as gluttons, ſtupid fellows, and unfit for any buſineſs in the ſtate, and before him Euripides had ſaid the ſame thing, and Galen tells us, that it was difficult to find a ſpark of reaſon in ſuch a monſtrous heap of fleſh. Every cobler could do what they did, roll themſelves whole days in duſt and mud. Beſides they were immoderately expenſive, always in debt, conſuming what they had gained by beaſtly labour on their brutal appetites.*

Not only philoſophers had them in averſion, they were deſpiſed equally by the greateſt generals. Alexander gave them no encouragement, never celebrating any of their games, and deſpiſing them as incapable of honour or profit. Philopœmen deteſted them, for rendering the fineſt bodies unfit for war, as from their exceſſes in ſleep and food, they were unable to bear the fatigues of a military life. †

From this account of the gymnaſtic life, it may ſeem ſurpriſing, that Lucian ſhould be a ſtrenuous defender of it, though he paſſes over in ſilence the objections made by Plato and Ariſtotle. This opinion of Lucian may be excuſable, ſince in ſpeaking in Solon's name, he deſcribes the arts known only in Solon's time, when the diſaſters attending them were not ſo common. But if we allow that Lucian is ſpeaking of the combatants of his own time, his inconſiſtency is not greater than that of introducing as he does, the names of philoſophers and ſophiſts as the inſtructors of youth, who were not known in the age of Solon.

Philoſophical Tranſactions of the Royal Society of London, for the Year 1793. *Part* II.

XII. *A Deſcription of a Tranſit Circle, for determining the Place of celeſtial Objects as they paſs the Meridian. By the Rev.* F. Wollaston, *LL. B. F R S.*

THIS inſtrument ſtands on a cylinder of ſolid ſtone, 25½ inches diameter, and three feet ſix inches long, bedded on a pier of brick, whoſe foundation is deep in the earth. The general form of the inſtrument is ſeen in Plate II. Fig. 1 and needs very little explanation.

" The whole ſtands on three feet, adjuſtable by ſcrews. The bottom plate (of 21¾ inches diameter) turns in azimuth; not on a long axis, but on a center; and rides on a bell-metal circle, truly turned, and to which the bottom plate itſelf is ground. In this way it moves very ſmooth by hand; but it is capable of being turned by a winch, with tooth and pinion. The intent of its turning thus, is merely for the convenience of reverſing the inſtrument: for, though it might be uſed out of the meridian, and for azimuths; yet, ſince it is deſigned principally for meridian paſſages, when it is in its place the whole is clamped firmly to the bottom frame by four clamps, which confine it to the circle on which it rides: and this method of turning proves itſelf to be ſteady, by the levels on the bottom plate never altering in the leaſt upon ſcrewing the clamps.

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* De repub. III. 208 Ed. Maſſey. Galen. Suas. ad. art. or. c. 6.

† Plut. IV. 11. II. 622. 623. Ed. Reiſk.

" The four pillars, and their braces, explain themſelves. They ſtand over the bell-metal circle; and the clamps are placed near the foot of each, for greater ſteadineſs; ſince they carry the Y*s* for the pivots of the tranſit.

" The conſtruction of theſe Y*s* is peculiar: they hang, as it were, in gimmals, though of a very firm kind, a drawing of which will beſt explain them. They have a horizontal motion, ſmooth and ſteady: the T, or frame, AB, which carries them, turning on a perpendicular axis of 2½ inches, CD, ground to its ſockets; on the outſide of the plate EF, which connects them with the pillars, and reſting on that plate, to which the bottom of the frame itſelf is ground likewiſe. In this frame they have a vertical motion: the Y*s* themſelves carrying a horizontal axis at AB, which, conſiſting of two fruſta of cones on each ſide, in contrary directions, with a collar over them, guards againſt any ſhake whatſoever, while it admits of the Y adapting itſelf to the direction of the pivot.

" By thus hanging the Y*s*, the pivots have a bearing on them from end to end; inſtead of riding on a bell-metal *ridge*, as is the uſual method where the Y*s* are fixed, and cannot ſet themſelves in the direction of the axis. This ſeems to be a better bearing, and much leſs likely to wear the pivots.

" Yet, to guard againſt any wear, a pair of cylindrical ſprings, included in a tube, are applied through rings within the connecting plate above mentioned. Theſe carry, each of them, a pair of rollers, on which a braſs collar at each end of the axis of the teleſcope rides. The ſprings may be uſed or removed, at pleaſure; and they can be ſtrengthened or weakened, by means of a ſcrew at the bottom of the tube, ſo as to take off from the pivots any part of the weight that may be judged beſt: and, ſince they are in a line with the axis, and are made capable of obeying it in every direction, there is no danger of their deranging its adjuſtments, while they render its motion exceedingly light and ſmooth indeed.

" The adjuſtments of the Y*s* are both of them at the ſame end of the axis, oppoſite to the divided circle and the microſcopes; becauſe the ſmalleſt adjuſtment of that end of the axis between the microſcopes, would have affected them ſo as to require an entire re-adjuſtment of them too. At the farther end, the axis is perforated, to admit light for illuminating the wires. And I find that (to my ſight at leaſt) it is much moſt agreeable to cloſe the aperture with a pale green glaſs. The axis itſelf is 18 inches long, excluſive of the pivots, which are about 1¼ each.

" The microſcopes are 9 inches long; the object-end at two inches from the limb of the circle. They magnify 24 times. One revolution of the micrometer-ſcrew is equal to one minute; and the head is divided to ſeconds.

" The fixed or ſtationary wire in them, is at the firſt notch, or minute itſelf; and it is adjuſted by means of a plumb-line, which hangs from the top plate, and paſſes by the ſide of the axis; at about 8 degrees, or 1 inch ¾, from the center. For this purpoſe there are dots made on the limb, at a ſuitable diſtance on each ſide of the zero, both above and below, whether the teleſcope be horizontal or perpendicular either way. Theſe are viewed through two compound microſcopes, (of 5½ inches long, and their object-glaſs at 3 inches diſtance from the limb) carried by the ſame frames as the other microſcopes.

" The curſor, or moveable wire, in the micrometer-microſcopes, is adjuſted much in the ſame way as General Roy's; excepting that the micrometer head is made to turn ſtiffly on the neck of the ſcrew, ſo as to allow of bringing the point of zero to front the eye, without the trouble of re-adjuſtment, if it happened to fall behind."

There is a level to adjuſt the axis. The circle has ten radii. The bottom bar over the moveable Y, in the brace between the pillars at A is omitted to give better room for paſſing the level, when the teleſcope is horizontal, and from the lower bar of the oppoſite brace B over the fixed Y, there ſtands out a forked piece of braſs to receive the leg at the level, and direct it to its place. The opening at the top is for the ſake of obſervations in the zenith. The circle is full two feet diameter at the diviſions, and 25½ inches at the edge. The teleſcope is of two inches aperture, and thirty-three feet focal length. The object glaſs ſcrews into the end of a piece of falſe tube four inches long, which ſlides on the outſide of the principal tube; by which means the whole aperture of the tube is gained, but there is ſome danger of diſturbing the collimation by touching the outſide of the tube.

The wires are in two diſtinct cells, five perpendicular at thirty-five ſeconds of time diſtance in the equator, three horizontal at about fifteen minutes of a degree aſunder, the ſets do not touch, and are adjuſtable in collimation by peculiar ſcrews. The two cells may be turned ſeparately on the axis of viſion, but, when brought at right angles to each other, may be fixed, and turned together and ſettled by ſcrews and collars at the outſide of the tube. There are three horizontal wires for the ſake of obſerving the lower limb of the ſun or moon at the one, and the upper limb at the other of the extreme wires, without much altering the elevation of the teleſcope, and removing the center of the object far out of the center of the field.

The exterior diviſions of the circle by dots, the interior by ſtrokes, at every ten minutes, were done by hand. The former give the altitudes, the latter the polar diſtances, and conſequently the number marked by one microſcope, muſt if the inſtrument is complete, be the complement of the number marked by the other. Theſe diviſions are numbered at every degree, from the eye end to the object end of the teleſcope, with the feet of the figures always towards the center. At a proper diſtance from the main pillars is a ſmall pillar, carrying a compound microſcope with a wire in its focus, which being adjuſtable and once ſet to the latitude of the place, gives immediately the north polar diſtance of any object ſeen, or by fixing the inſtrument according to the polar diſtance of an object ſought, one is certain of its entering at the proper time the field of the teleſcope near the center wire. This pillar for the polar microſcope may be removed, when the inſtrument is reverſed to the other ſide of the main pillars.

On examining the circle with the microſcopes, to ſee whether the oppoſite dots were exactly in the diameter of the circle, as long as it was turned round the ſame way, they were perfectly true, but on a few revolutions the contrary way, an error was diſcovered. The cauſe of this was after various conjectures found to be in the Y*s*, which could ſcarcely be called by that name, ſince a little hollow had been made on each ſide to receive the pivots. They were then taken out and formed to an exact right angle, with perfectly ſmooth ſides, and the error was removed.

From the convenience of this inſtrument, in taking the altitude together with the tranſit of an object, it is peculiarly uſeful in every obſervatory, and a teleſcope of forty five inches, with a circle of about three feet ſix inches, on ſtone piers will anſwer every purpoſe. If the teleſcope is of five feet, the circle muſt be of four feet ſix inches, and beyond this ſize the additional weight of metal, and the diſparities in ſuch a maſs would counteract every other advantage.

This inſtrument upon trial has been found a very uſeful one, and the beſt adapted of any known by the writer, to the perfecting of our catalogues. In general obſervations on the ſame ſtar ſeldom differ from each other above five ſeconds in altitude, and are moſt commonly within that limit. The two exterior horizontal wires are very convenient. They are 14′..43″,5 of a great circle diſtant from the center, and thus without hurry the preceding limb of the ſun may be obſerved at three wires, the lower limb then ſet to the upper wire, and read off the upper limb to the lower wire, and then one is in readineſs to obſerve the ſecond limb of the ſun, at the 3d, 4th and 5th wires, and to read off the upper limb after the obſervation is ended.

On the whole, much may be done by ſuch an inſtrument, and one between piers would be highly advantageous to aſtronomy; it is a complete tranſit inſtrument, and beſides the right aſcenſion and altitude of an object are aſcertained at once, without any trouble. As an additional advantage from its form, the whole may be reverſed in a few minutes, and thus any errors are diſcovered, which may be in the inſtrument itſelf, or may at any time ariſe in obſerving.

XIII. *Deſcription of an extraordinary Production of Human Generation, with Obſervations.*

By John Clarke, *M. D.*

A Woman in a lying-in hoſpital was delivered of a healthy child, after which was expelled the ſubſtance here deſcribed. " It was incloſed in a diſtinct bag of membranes, compoſed of decidua, chorion, and amnios, and had a placenta belonging to it; the ſide of which was attached to the placenta of the perfect child. The membranes had been opened before I ſaw it, and a ſmall quantity of liquor amnii having been diſcharged, the contents of the cavity were expoſed.

" The ſubſtance contained in the membranes was of an oval figure, rather flattened on the two ſides. Its long diameter was about four inches; and its ſhort diameter, from edge to edge, three inches. One edge was rather more concave than the other, and near the center of it there was a ſmall and thin funis, in length about an inch and half, by means of which it was connected to the placenta.

" The ſurface of this ſubſtance was covered with the common integuments, and from it iſſued four projecting parts. Of theſe the upper is an imperfect reſemblance of the foot of a child, having one large and three ſmaller toes upon it. The lower is a ſtill more imperfect imitation of a foot, having one large and two ſmaller toes.

" Between the two feet is ſituated a ſmall and rounded projection; into which a ſmall paſſage led, capable of containing a large briſtle, but it ſoon terminated in a *cul de ſac*. Cloſe to the funis there was another ſmall and thin projection, about a third of an inch in length, which looks like a finger, and was found to contain bony matter, and joints.

" There was no appearance of head or neck. No ribs could be felt, nor clavicle, nor ſcapula. There was no veſtige of any thing like legs, or thighs, or upper extremities; or of organs of generation.

" The only external ſimilarity of this monſter to a human fœtus, conſiſts of its covering, and the attempt at a formation of two feet and a finger.

" Before the internal ſtructure was examined, the navel-ſtring of the perfect fœtus was injected, from whence the injection very readily paſſed through both placentæ, viz. that of itſelf, and that of the monſter; and then into the ſubſtance of the monſter alſo, as appeared by the redneſs of the ſkin.

" When the injection had become cold, the ſkin was carefully diſſected off: in doing which it was found that the upper foot had no bony connection, but grew looſe, and only connected to the internal parts by cellular ſubſtance. The lower foot was articulated to the inferior part of the tibia and fibula.

" The internal ſtructure of the monſter was compoſed of ſoft and bony matter. Upon cutting into the former, it appeared of a homogeneous fleſhy texture, but without any regular or diſtinct arrangement of muſcular fibres; and was very vaſcular throughout.

" The bones which were ſurrounded by this fleſhy ſubſtance were the os innominatum, the os femoris, the tibia, and the fibula. The relative ſituation of theſe to each other deſcribed the attitude of kneeling. With regard to the bones themſelves, the os innominatum, and the os femoris are both perfect, and of the ſize which we meet with in a fœtus at the full period of utero-geſtation; but the tibia and fibula are much ſhorter than in their natural proportion to the thigh bone.

" At the upper part, and towards the inſide of the os innominatum, was placed a little portion of ſmall inteſtines, looſely connected, by their meſentery, to the poſterior edge of that bone, where it is commonly united to the os ſacrum. Theſe inteſtines had a covering of peritonæum, and were very minutely injected.

" The next object was to trace the veſſels of the funis, which was done with great care. There appeared to be only two, viz. an artery, and a vein; and theſe paſſed on towards the inner ſurface of the os innominatum. As they approached this bone, they gave off ſome branches to the ſurrounding parts, which quickly became too ſmall to be traced. The trunks then paſſed backward, towards that part where the articulation with the os ſacrum is generally found; at which place they went to the other ſide of the bone, where they diſtributed a great number of ſmall branches, and were at length loſt in the ſurrounding parts.

" This was the whole of the internal conſtruction of this very extraordinary monſter. There was not the ſmalleſt appearance of head, or vertebræ, or ribs. There was neither brain, ſpinal marrow, nor nerves. It had no heart, nor lungs. It contained none of the viſcera ſubſervient to digeſtion, excepting the inteſtines already mentioned; nor any glandular ſubſtance whatſoever."

The writer's obſervations relate to the preſumptive proof afforded by this extraordinary production, of the ſimplicity of function of animals in the fœtal ſtate. In this inſtance, the actions muſt have been that of the vaſcular ſyſtem ſolely, and unaſſiſted by a heart; which yet appears to have been capable of forming a variety of parts, as bone, ſkin, cartilage, ligament, &c.

XIV. *Deſcription of an Inſtrument for aſcertaining the ſpecific Gravities of Fluids.* By JOHN GODFREY SCHMEISSER.

" THE whole apparatus is repreſented in Plate I. Fig. 8. It conſiſts of a flat-bottomed glaſs bottle in which is fitted, by grinding, a glaſs ſtopper having a thermometer paſſing through it. The bore of this ſtopper is conical, and the thermometer has a glaſs collar, which is ground into the bore of the ſtopper, ſo as to be perfectly tight. There is ſome difficulty both in making the glaſs collar, and in fitting it into the ſtopper. If the thermometer tube and the collar be not made of the ſame metal, the collar is very apt to fly off in grinding; for this reaſon I have ſometimes fixed the tube into the ſtopper by means of a thin piece of elaſtic gum, wound very tight round the tube. This gum, by its elaſticity, effectually excludes air and liquids, and is, in the uſual temperature of the atmoſphere, not diſſolved by any liquor, except vitriolic æther, and not even by that, unleſs is it particularly prepared for the purpoſe.

" The cavity left at the upper part of the ſtopper may be filled up with ſealing wax, or any other kind of cement; this will aſſiſt in fixing the tube, and as the liquors to be weighed do not come in contact with this part, if the bottle be carefully filled, there is no danger that the wax, or cement made uſe of, ſhould in any degree affect the accuracy of the experiments."

To uſe it, an accurate cubic inch, faſtened by horſe hair to an hydroſtatical balance, is immerſed in diſtilled water, of temperature ſixty degrees by Fahrenheit, and from the weight loſt, the weight of a cubic inch of this water is conſequently determined. The inſtrument itſelf is then accurately weighed, taking care to deduct the weight of the air contained in the bottle. The bottle is then filled with diſtilled water of the temperature of ſixty degrees, and, the weight of this water being aſcertained, the quantity of water may be found in cubic inches. Fill the bottle then with any other fluid of the ſame temperature, and aſcertain its weight, which, compared with the weight above found of the diſtilled water, gives the ſpecific gravity of the fluid. To bring the fluid to the temperature of ſixty degrees, ſet the bottle in cold water, and add as much warm water to it, as may be neceſſary to bring it to the deſired temperature. If fluor acid is to be weighed, coat the inſide of the bottle with melted wax; this coating may eaſily be removed afterwards by a little oil of turpentine or any other eſſential oil.

XV. *Extract of a Letter from Sir Charles Blagden, Knt. S. R. S. to Sir Joſeph Banks, Bart. P. R. S. giving Account of the Tides at Naples.*

BY this it appears, that from an obſervation made by the writer on the ſecond of March, it was high water at Naples about eleven in the forenoon, and low water between five and ſix in the afternoon, with a difference of pretty exactly one foot in the height. The wind blew the ſame way all the time, and the ſea was very little agitated. On the preceding day the water had ſunk an inch or two lower. The time of high water at full and change is, from this and other leſs accurate obſervations concluded to be between nine and ten o'clock in the bay of Naples.

XVI. *Obſervations on Viſion.* *By* Thomas Young.

TO account for the mode by which the eye is enabled to accomodate itſelf to the viewing of objects at a leſs diſtance than that of eaſy or indolent viſion, has long been attempted by philoſophers; and a variety of hypotheſes relative to ſuppoſed powers of different parts of the eye to effect this accommodation, have been framed. The principal of theſe are enumerated by the preſent writer, with a brief refutation. He then proceeds to ſtate his own opinion, with the diſcovery on which it was founded.

" In cloſely examining, with the naked eye in a ſtrong light, the cryſtalline from an ox, turned out of its capſule, I diſcovered a ſtructure which appears to remove all the difficulties with which this branch of optics has long been obſcured. On viewing it with a magnifier, this ſtructure became more evident.

" The cryſtalline lens of the ox is an orbicular, convex, tranſparent body, compoſed of a conſiderable number of ſimilar coats, of which the exterior cloſely adhere to the interior. Each of theſe coats conſiſts of ſix muſcles, intermixed with a gelatinous ſubſtance, and attached to ſix membranous tendons. Three of the tendons are anterior, three poſterior; their length is about two thirds of the ſemi-diameter of the coat; their arrangement is that of three equal and equidiſtant rays, meeting in the axis of the cryſtalline; one of the anterior is directed towards the outer angle of the eye, and one of the poſterior towards the inner angle, ſo that the poſterior are placed oppoſite to the middle of the interſtices of the anterior; and planes paſſing through each of the ſix, and through the axis, would mark on either ſurface ſix regular equidiſtant rays. The muſcular fibres ariſe from both ſides of each tendon; they diverge till they reach the greateſt circumference of the coat, and, having paſſed it, they again converge, till they are attached reſpectively to the ſides of the neareſt tendons of the oppoſite ſurface. The anterior or poſterior portion of the ſix viewed together, exhibits the appearance of three penniformi-radiated muſcles. The anterior tendons of all the coats are ſituated in the ſame planes, and the poſterior ones in the continuations of theſe planes beyond the axis. Such an arrangement of fibres can be accounted for on no other ſuppoſition than that of muſcularity. This maſs is incloſed in a ſtrong membranous capſule, to which it is looſely connected by minute veſſels and nerves; and the connection is more obſervable near its greateſt circumference. Between the maſs and its capſule is found a conſiderable quantity of an aqueous fluid, the liquid of the cryſtalline.

" I conceive, therefore, that when the will is exerted to view an object at a ſmall diſtance, the influence of the mind is conveyed through the lenticular ganglion, formed from branches of the third and fifth pairs of nerves, by the filaments perforating the ſclerotica, to the orbiculus ciliaris, which may be conſidered as an annular plexus of nerves and veſſels; and thence by the ciliary proceſſes to the muſcle of the cryſtalline, which, by the contraction of its fibres, becomes more convex, and collects the diverging rays to a focus on the retina. The diſpoſition of fibres in each coat is admirably adapted to produce this change; for, ſince the leaſt ſurface that can contain a given bulk is that of a ſphere, (Simpſon's Fluxions, p. 486) the contraction of any ſurface muſt bring its contents nearer to a ſpherical form. The liquid of the cryſtalline ſeems to ſerve as a ſynovia in facilating the motion, and to admit a ſufficient change of the muſcular part, with a ſmaller motion of the capſule.

" It remains to be inquired, whether theſe fibres can produce an alteration in the form of the lens ſufficiently great to account for the known effects.

" In the ox's eye, the diameter of the cryſtalline is 700 thouſandths of an inch, the axis of its anterior ſegment 225, of its poſterior 350. In the atmoſphere it collects parallel rays at the diſtance of 235 thouſandths. From theſe data we find, by means of Smith's Optics, Art. 366, and a quadratic, that its ratio of refraction is as 10000 to 6574. Haukſbee makes it only as 10000 to 6832,7, but we cannot depend on his experiment, ſince he ſays that the image of the candle which he viewed was enlarged and diſtorted; a circumſtance that he does not explain, but which was evidently occaſioned by the greater denſity of the central parts. Suppoſing, with Haukſbee and others, the refraction of the aqueous and vitreous humours equal to that of water, viz. as 10000 to 7465, the ratio of refraction of the cryſtalline in the eye will be as 10000 to 8806, and it would collect parallel rays at the diſtance of 1226 thouſandths of an inch: but the diſtance of the retina from the cryſtalline is 550 thouſandths, and that of the anterior ſurface of the cornea 250; hence (by Smith, Art. 367,) the focal diſtance of the cornea and aqueous humour alone muſt be 2329. Now, ſuppoſing the cryſtalline to aſſume a ſpherical form, its diameter will be 642 thouſandths, and its focal diſtance in the eye 926. Then, diſregarding the thickneſs of the cornea, we find (by Smith, Art. 370,) that ſuch an eye will collect thoſe rays on the retina, which diverge from a point at the diſtance of 12 inches and 8 tenths. This is a greater change than is neceſſary for an ox's eye, for if it be ſuppoſed capable of diſtinct viſion at a diſtance ſomewhat leſs than 12 inches, yet it probably is far ſhort of being able to collect parallel rays. The human cryſtalline is ſuſceptible of a much greater change of form.

" The ciliary zone may admit of as much extenſion as this diminution of the diameter of the cryſtalline will require; and its elaſticity will aſſiſt the ſellular texture of the vitreous humour, and perhaps the gelatinous part of the cryſtalline, in reſtoring the indolent form.

" It may be queſtioned whether the retina takes any part in ſupplying the lens with nerves; but, from the analogy of the olfactory and auditory nerves, it ſeems more reaſonable to ſuppoſe that the optic nerve ſerves no other purpoſe than that of conveying ſenſation to the brain.

" Although a ſtrong light and cloſe examination are required, in order to ſee the fibres of the cryſtalline in its intire ſtate, yet their direction may be demonſtrated, and their attachment ſhewn, without much difficulty. In a dead eye the tendons are diſcernible through the capſule, and ſometimes the anterior ones even through the cornea and aqueous humour. When the cryſtalline falls, it very frequently ſeparates as far as the center into three portions, each having a tendon in its middle. If it be carefully ſtripped of its capſule, and the ſmart blaſt of a fine blow-pipe be applied cloſe to its ſurface in different parts, it will be found to crack exactly in the direction of the fibres above deſcribed, and all theſe cracks will be ſtopped as ſoon as they reach either of the tendons. The application of a little ink to the cryſtalline is of great uſe in ſhewing the courſe of the fibres."

When the writer firſt obſerved this ſtructure of the cryſtalline, he did not know that its muſcularity had before been ſuſpected. But he finds that Deſcartes ſuppoſed it to be of this nature; and Leeuwenhoek, accurately deſcribed the fibres of the cryſtalline in various animals, and even called it a muſcle. (See *Ph. Tranſ.* V. XXIV. p. 1729). Mr. Young has not yet examined the human cryſtalline, but from its readily dividing into three parts, he infers its ſimilarity to that of the ox.

Plate V. Fig. 1. Repreſents the ſtructure of the cryſtalline lens, as viewed in front.

Fig. 2. A ſide view of the cryſtalline.

XVII. *Obſervations on a Current that often prevails to the weſtward of Scilly; endangering the Safety of Ships, that approach the Britiſh Channel.*

By JAMES RENNELL, *Eſq. F. R. S.*

THE loſs of ſeveral ſhips on the Scilly iſles, is attributed in this paper to a current, with the effects of which navigators have hitherto not been ſufficiently acquainted. There is by all accounts a current ſitting round the capes of Finiſterre and Ortegal into the bay of Biſcay. It ſets to the eaſtward along the coaſt of Spain, and continues its courſe along the coaſt of France to the north and north-weſt. The cauſe of this current is the prevalence of weſterly winds in the Atlantic, upon the ſtrength and continuance of which depends the extent of the current: and as currents preſerve for a conſiderable time the direction they received from the laſt coaſt, by which they ran, it is probable that the current of the bay of Biſcay continues its courſe about N. W. by W. from the coaſt of France, to the weſtward of Scilly and Ireland.

At times this current may not be ſtrong enough to preſerve its direction acroſs the mouth of the Britiſh channel; but, after hard and continued gales of wind from the weſt, it will be felt not only in the parallel of Scilly, but in that of the ſouth-weſt coaſt of Ireland. Common obſervation ſhews the effect of wind on water to produce a current. In a canal four miles long, the water was kept up four inches higher at one end than the other, by the action of wind along the canal. A ſtrong ſouth-weſt or north-weſt wind raiſes very high tides in the Britiſh channel or in the Thames and on the eaſtern coaſts; ſince the accumulated water cannot eſcape faſt enough by the ſtraits of Dover to preſerve the level. A ſtrong north-weſt wind of any continuance raiſes the Baltic at leaſt two feet, and the Caſpian Sea is higher at one end than the other, as a ſtrong northerly or ſoutherly wind prevails. Thus as water, which cannot eſcape, is raiſed up in ſome places by the wind, in others by the ſame cauſe a current will be produced, and its extent will depend on the force by which it is ſet in motion.

A ſimilar current does from weſterly winds prevail in the Britiſh channel, but from being blended with the tides it is ſcarcely to be perceived. The form too of the channel does not permit the ſame effects to be produced in it as in the bay. The bay is on many accounts remarkable. The uncommon degree of agitation remarked in it in ſtormy weather may be owing to the cauſe which produces the current, or to the current itſelf. In the firſt inſtance, the reſiſtance made to the water by the land, occaſions (as has been exemplified by Mr. Smeaton's mode of quieting Ramſgate harbour) a reverberation, making the ſurface of a great part of the gulph very unquiet. The effect of a current running to windward, is to produce a ſhort hollow and dangerous wave, and conſequently when the current is ſtrong, and the wind freſh from the north-weſt, the agitation of the waters in the north part of the bay muſt be conſiderable.*

We have not as yet ſufficient data to determine, at what time from the commencement of ſtrong weſterly gales in the Atlantic and bay of Biſcay, the current may produce an effect on tracks of ſhips near Scilly; but the prevalence of ſuch winds will be the ſignal for the appearance of a current between Uſhant and the ſouth-weſt coaſt of Ireland. The facts on which the exiſtence of this current is founded are theſe.

In 1778, the Hector Eaſt-Indiamen encountered in croſſing the eaſtern part of the Atlantic between the parallels of 42 and 49, very ſtrong weſterly gales, varying two or more points to the north and ſouth of weſt, but blowing longeſt from the northern points. Between the 16th and 24th of January, it blew with uncommon violence, and the ſtorm extended from the coaſt of Nova Scotia to that of Spain. On the 30th of January, when the ſhip was within 60 or 70 leagues of the meridian of Scilly, between the parallels of 49 and 50, the current was perceived, which in two days ſet the veſſel to the north of its intended parallel, by near half a degree, and the wind inclining to the ſouth prevented it from regaining the parallel. The direction alſo of the current being more weſterly than northerly, we were driven near thirty leagues to the weſt, for we had ſoundings in 73 fathoms in the latitude of Scilly, and afterwards ran 150 miles by the log directly eaſt, before we came the length of the iſlands, and in running 120 miles we ſhallowed the water only nine fathoms. We were ſenſible of this current by the obſervations of latitude, by riplings on the ſurface of the water and by the direction of the lead line, and being driven to the north of Scilly were barely able to get through between thoſe iſlands and the Land's end. From our ſoundings, and in formation from a veſſel which had only juſt entered the current, we may conclude, that it extends from Scilly ſixty leagues, and its breadth may probably be little more than thirty leagues, as we croſſed it very obliquely and perhaps in the wideſt part.

From the journal of the Atlas Eaſt-Indiaman, which had time-keepers on board, we have clearer proofs of the exiſtence of the current and the rate of its motion. The Atlas had on the 27th of January, 1787, advanced with a fair wind 55 leagues to the weſtward of Uſhant, when a violent gale began at ſouth, and about 11 hours afterwards changed ſuddenly to the weſtward. On the 28th it was generally W by S, and WSW, on the 29th SW by W, or more ſoutherly, on the 30th and 31ſt SSW, to SW, by S. During this time the ſhip was generally lying to with her head to the NW. On the 1ſt of February the gale abated, but on the following day returned, and continued with little intermiſſion, blowing between S and WNW, but chiefly and moſt violently from WSW and SW. On the 8th and 9th it blew, ſays the journal, a mere hurricane. On the 11th, the weather being more moderate and the wind favourable, the ſhip proceeded on its courſe ſouthward, being two degrees and a quarter to the weſt of Finiſterre by the reckoning, but by the time-keepers more than four degrees and a half.

To this account the following particulars may be ſubjoined. At noon when the gale begun, the longitude by reckoning was within 14 minutes of that by the time-keepers, the latter being the moſt weſterly. This difference may have ariſen from an error in the log, in the poſition of the needle, or to the weſterly current which the ſhip was in on the 27th. The differences were but trifling on the three following days, and on the 30th had amounted only to 24 minutes, when the ſhip was about 24 leagues WSW of Scilly, and at 25 leagues SW by W from Scilly, they had ſoundings at 70 fathoms. From this laſt circumſtance it appears, that the longitude 8°..28′ ſhewn by the time-keepers weſt from London was nearly that of the ſhip. The longitude of St. Agnes Scilly being 6°..46′.

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* In the ſame manner a ſwell raiſed by a ſtrong gale at ſouth or ſouth-weſt in the tract of variable winds has been felt very far within the limits of the ſouth eaſt trade wind in the Indian Ocean.

Here the Atlas was aſſiſted by the current, which had delayed the Hector, and carried clear of the ſouth-weſt coaſt of Ireland. On the 31ſt, the time-keepers ſhewed that the ſhip had ſet very conſiderably to the weſtward of the reckoning, and by the 2d of February, at three in the afternoon, that is in fifty-one hours, ſhe had ſet two degrees of longitude to the weſt of the reckoning. On the 3d of February at noon, that is forty-five hours after, a further ſet appeared of 23 minutes of longitude, ſo that in four days the ſhip had been carried by the current two degrees and twenty-three minutes, and from the beginning of the gale 2°..32′ long. or ninety-nine miles. Here, or even before the time of obſervation on the 3d, the current appears to have left them as the differences on the following days, which at ſometimes are to the eaſt, at others to the weſt, may rather be aſcribed to the errors of the log, than to the effects of a current. Hence we may infer, that the Atlas experienced a weſterly current, from a point about twenty-four leagues to the W S W of Scilly, to four degrees of longitude weſt of the meridian of Cape Clear in the parallel of 51°, the ſtream going off to the northward between this track and the ſouth-weſt coaſt of Ireland.

There are two particulars in this caſe which are not eaſily accounted for. Firſt, the current was felt in its apparently full ſtrength the fourth day after the commencement of the gale, preceding which the winds in the channel had been eaſterly for three days, and the fourth day there had been ſtrong gales at S W, and the five days preceding that there had been chiefly light winds at weſt. From this ſtatement we may ſuppoſe the current to have originated from a vaſt body of water pent up in the bay of Biſcay by gales, firſt from the ſouthward eleven hours, then a point or two to the ſouth of weſt, and laſtly at ſouth-weſt, and this body to have run along the S W coaſt of Britany, and thence preſerving the direction acquired by running along the laſt coaſt, to have gone to the north-weſtward.

Secondly, there is not a northern ſet indicated in the journal of the Atlas. But this will not prove that there was not a northing, as they had not obſervations of latitude regularly, and on the 31ſt of January, when lying to, thirty-ſix miles which appears exceſſive, are allowed for twenty hours drift to the north-weſt. On that day, and on the ſecond, in a very important point of the track, there was no obſervation, and the two miles northing ſhewn by the obſervation of the firſt proves nothing. In the Hector a conſiderable degree of northing was obſerved on two days about twelve miles each, on another thirteen, and two others nine and eight, and this ſet to the northward was indicated alſo by the lead line, and the ripling on the ſurface of the water.

From hence it may be remarked, that, firſt, whatever may be the breadth of the ſtream, if a ſhip croſſes it very obliquely, ſhe will be more affected by it than if ſhe ſteered directly acroſs it; and if the eaſtern border has a more northerly direction than

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the middle, this circumſtance ſhould be guarded againſt. The ſtream is alſo probably broader in the parallel of Scilly than farther ſouth, and hence they, who have been carried by the force of the current to the north of Scilly, may think themſelves fortunate in its being ſo ſtrong, as they might otherwiſe have been carried on the rocks.

Secondly, after a good obſervation in latitude at noon, one may run eaſtward during a long night, but after ſtrong weſterly gales in the Atlantic, in approaching the channel with light ſoutherly winds, it would be better either to make Uſhant, or to keep within the parallel of 48° 45′. In 49° 30′, the current will have its full effect, where the danger is the greateſt but in 48° 45′, if aſſailed by a north-weſt current, the ſhip may, by a ſoutherly wind be carried into the channel.

Thirdly, Ships bound to the weſtward with the wind in the ſouth-weſt, by preferring the larboard tack, will have the benefit of the current.

Fourthly, the lighthouſe of Scilly, which is either removed or to be removed to the ſouth-weſt of the iſlands, ſhould be very lofty. The light has never appeared clear and bright as a light to direct ſhips ought to do.*

Fifthly, as the preſent chart of ſoundings is very bad, it would be uſeful to ſend a veſſel with time-keepers to take the ſoundings between the parallels of Scilly and Uſhant, from the meridian of the Lizard point to as far weſt as the moderate depths extend. By ſuch a ſurvey the want of obſervations of latitude and longitude might be ſupplied, and the danger of the current avoided.

Sixthly, there are two things which ſhould be aſcertained, firſt, the point at which the two tides of St. George's and the Britiſh channel ſeparate on the weſt of Scilly. Secondly, the degree of northing one ſtream has more than the other. By knowing theſe points the danger of getting into too northern a parallel may be avoided.

XVIII. *Obſervations on the Planet Venus.* *By* William Herschel, *LLD. F.R.S.*

THESE obſervations were made with a view of aſcertaining the diurnal rotation of this planet, the nature of its atmoſphere, the magnitude of its real diameter, and the conſtruction of the planet, with regard to ſuch appearances as are aſcribed to ſeas, continents or mountains. The late wonderful properties aſcribed to Venus, ſuch as its mountains twenty-three miles in height, a ragged margin reſembling the uneven border of the moon, ſeen by a power from 1 to 4, one cuſp appearing pointed, and the other blunt, owing to the ſhadow of ſome mountain, have not been diſcovered by the writer, to whom want of attention, or a deficiency of inſtruments will hardly be imputed, and the flat ſpherical forms of Saturn remain to him equally unknown. †

Obſervations.

No ſpot viſible on Venus with 7-feet reflector on April 17, 1777, or on April 26, with 10-feet reflector, though the diſk was bright and well defined on both days, or on February 21, 1780, diameter 15″,9 mean of three meaſures. No ſpot on May 2, 1780, power 449 diameter, 17″,2, or on 28, power 268 and 449, diameter 22″,8, or on 29 power 447 edge ſharp and well defined.

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* The light we underſtand is now a remarkable fine one. It revolves, and being at every revolution obſcured for a time, muſt be well known by every navigator.

† Vol. I. page 160. No. XVI.

June 19, a bluiſh, darkiſh ſpot meets a rather bright one in an angle, vertex about a third of the diameter from one of the cups. June 21, 23, 24, 25, 26, 28, 29, 30. July 3, with a 20-feet Newtonian reflector, power generally 300 and 450, ſpots extremely faint and changeable, from which it is evident that Venus has a motion on its axis and an atmoſphere, as the changes obſerved can hardly be upon the ſolid body of the planet. No ſpot on September 18, diameter 38″,4, or on October 10, with a perfect 7-feet ſpeculum, power 227, 460 and 932, diameter 41″,3, or on October 11, diameter 27″,8, or on October 20, 21, 23. On April 17, 1783, with 10-feet reflector, power 324, ſome darkiſh ſpots ſeen, as alſo with 7-feet reflector, power 227, but not defined enough for the determining of the rotation. May 21, with 10-feet reflector, a new ſpeculum and power 250, at 7*h*..30′ no ſpot, 8*h*..30′ an ill defined ſpot, 9*h*..15′ no motion to be depended on, but the figure ſeems rather advancing towards the center. May 30, 31, and June 1, 6, ſpots obſerved with 10 and 20-feet reflectors, and motions perceived in them. No ſpot on December 3, with 460, and 932, or on February 13, 1785, with a new 10-feet Newtonian reflector, or on April 8, 1788. On November 30, no ſatellite viſible. If ſhe has one it muſt be leſs in appearance than a ſtar of the 8th or 9th magnitude, power 300. No ſpot on December 2, 1789, power 157, 300, 460, or on May 23, 1791, with 40 feet reflector. Superior light of this teleſcope an inconvenience.

November 24. Correction of the clock 46″,7, diameter meaſured with 20-feet reflector, power 157, 12*h*..18′, 1ſt. meaſure 45″,486. 2d. 46,142. 3d. 45,514. 4th. 45,814. 5th. 46,033. 6th. 46,252. Mean. 45″,874. With power 300, 12*h*..36′ 1ſt. meaſure 44″,885. 2d. 45,705. 3d. 45,104. 4th. 45,322. 5th. 45,842. Mean. 45,372. Mean of the two ſets 45″,623. The ſpeculum having been lately repoliſhed, tables were made for caſting up the meaſure by the following tranſits.

" November. 25, 1791. Tranſits of equatorial ſtars, taken to determine the value of the micrometer, which is divided into revolutions of ſixty parts each.

" Firſt ſet, 23″,0 23,0 23,0 23,0 23,2 23,1 23,1 23,0 23,1 23,1 = 23″,06 = 21 revolutions; correction + 7,2 parts, for zero and concave wires.

" Second ſet, 16″,8 16,6 16,4 16,5 16,7 16,6 16,5 16,8 16,4 16,5 = 16,58 = 15 revolutions 1,3 parts. Correction + 7,2.

" By the firſt ſet, 1 part = 0″,272964
" Second ſet - - 273748

" Mean of the two ſets 0″,273356

" In the firſt ſet, the micrometer was opened to 21 revolutions; and ten equatorial ſtars were obſerved to paſs from one wire to the other. The opening was afterwards changed, and ten other ſtars were again obſerved to paſs over the wires; after which the micrometer was read off, and found to be 15 revolutions and 1,3 parts."

February 4, 1793. Correction of the clock 1′..28″. At 2*h*..55′ with 7-feet reflector, power 172. Venus well defined, but no ſpot or appearance of a mountain, with power 215, no inequality in the line ſeparating light from darkneſs, with 287 and 430 very diſtinct, but no mountains or inequality, though the terminating line is not ſo ſharply defined as the circumference. With the latter power were ſeen on

Saturn, the equatorial belt, the ſhadow of the ring on Saturn, and of Saturn on the ring, the diviſion of the ring, &c.

March 3. Correction of the clock, 2′..0″,6. At 6*h*..30′ with 7-feet reflector, and various powers, no ſpots ſeen on Venus. April 3. Correction of the clock, 2′..43″,9 at 9*h*..9′, with 7-feet reflector, powers 215, 287, 430, no ſpots, horns equally ſharp, no appearance of mountains. The ſame appearances on April 4, when correction was 2′..45″,3. On April 5, correction being 2′..46″,7. On April 6, correction being 2′..48″,1. On April 7, correction being 2′..49″,6. And on April 8, correction being 2′..51″, at 9*h*..2′, with 10-feet reflector, power 300 and 400.

April 9. Correction 2′..52,1, at 8*h*..45′, with 10-feet reflector, power 300 and 400, as before, but the light of Venus is brighter around the limb than on the part ſeparating the enlightened from the unenlightened part of the diſk. 9*h*..16′, the bright part on the limb like a bright bead of nearly equal breadth all round. April 16. Correction 2′..59″,5—at 10*h*..3′, with 7-feet reflector as before. April 20. Correction, 3′..3″,8, at 10*h*, with powers up to 860 as before. With 287 a narrow luminous border around the limb leſs bright, but not conſiderably ſo near the terminating line than farther from it, with inferior powers not ſo well diſtinguiſhed. April 22. Correction 3′..5″,9, powers up to 1720 as before, at 10*h*..20′, with 430, the luminous margin compared to the light adjoining it, may be expreſſed by ſuddenly much brighter all around the limb.

April 28. Correction 3′..12″,3. 29. Correction 3′..13″,4. May 1. Correction 3′..15″,5. 5. Correction 3′..19″,8. 12. Correction 3′..27″,3. On theſe days with various powers, no ſpots, horns perfectly alike, no appearance of mountains. The ſlender part of the creſcent often appears knotty, which ariſes from undulations in the air, and little ſcratches in either of the ſpeculums may produce ſeeming irregularities. The illuminated part appears often more than a ſemicircle, this ariſes from the exceſs of the ſun's diameter, or the twilight of the atmoſphere.

May 13. Correction 3′..28″,4. The points of the horn appear blunter than they were laſt night, owing to the badneſs of the weather. 18. Correction 3′..33″,7. 19. Correction 3′..34″,7. Horns exceedingly ſlender, brought to very fine points. 20. Correction 3′..35″,8. Meaſured the diameter and projection of the cuſps beyond an hemiſphere by my diſk micrometer. Firſt meaſure with double eye glaſs, power 90, too low to be accurate diameter 2390. Projection 500. Second meaſure, power 215, diameter 4800, projection 620, too ſmall. The mean may not be far from the true diameter 3595, projection 560.

From theſe obſervations we may conclude, that Venus has a rotation on its axis, but the time as well as the poſition of the axis are involved in uncertainty. The atmoſphere is probably very conſiderable, as appears both from the changes in the ſpots, and the illumination of the cuſps, reaching beyond a ſemicircle when the planet is near its inferior conjunction. This inference was firſt made by Schroeter, who however overlooks the penumbra ariſing from the ſun's diameter, and his meaſures from the tarniſhing of his reflector are alſo defective. On the extent of the twilight, my computations ſhew that it is greater than that given by Schroeter: but they are not founded on a ſufficient number of accurate obſervations to draw a poſitive concluſion on this ſubject. Though from analogy it may be inferred that there are mountains on this planet, better inſtruments and better eyes are required to diſcover them. The real diameter may be aſcertained from the meaſures taken with the 20-feet reflector, on the 24th of November 1791, which give 18″,79 for the apparent diameter. From hence Venus appears to be a little larger than the earth, but though the meaſures were taken with great preciſion, we ſhould repeat them under the moſt favourable circumſtances before the queſtion is abſolutely dicided.

The phænomenon of the bright margin may be aſcribed to an atmoſphere, which like our own reflecting and refracting light in all directions, will on the border increaſe the luminous appearance. Thus the bright belts on Jupiter are owing to the parts where the atmoſphere is moſt filled with clouds, and as Venus has a very denſe atmoſphere, the ſurface of the planet will be ſeldom ſeen. There will be conſequently fewer ſpots obſerved on this planet, and they will appear generally of a darker colour than the reſt of the body.

XIX. *Abſtract of a Regiſter of the Barometer, Thermometer, and Rain, at Lyndon, in Rutland. By* THOMAS BARKER, *Eſq; with the Rain in Surrey and Hampſhire, for the Year* 1792; *and a Compariſon of wet Seaſons. Communicated by* THOMAS WHITE, *Eſq. F.R.S.*

		Barometer.			Thermometer.						Rain.			
					In the Houſe.			Abroad.			Lyndon.	Surrey.	Hampſhire.	
		Higheſt	Loweſt.	Mean.	High.	Low.	Mean	High.	Low.	Mean		South Lambeth.	Selbourn.	Fyfield
		Inches.	Inches.	Inches.	°	°	°	°	°	°	Inches.	Inches.	Inches.	Inches.
Jan.	Morn.	29,92	28,47	29,18	47½	30	39	46½	16	34½	2,097	2,51	6,07	4,47
	Aftern.				49	30½	39½	51½	25	38½				
Feb.	Morn.	94	29,04	48	47½	32	41	47½	16½	35	0,712	1, 5	1,68	1, 6
	Aftern.				49	34	42	55	26	42½				
Mar.	Morn.	30,00	28,53	26	50	35	44	48½	25½	39	1,096	2,13	6,70	2,92
	Aftern.				51	35½	45	57	30½	47½				
Apr.	Morn.	29,85	72	42	60	43½	51	56	36½	46	4,042	2, 4	4,08	2, 9
	Aftern				62	44	53	71	39	57				
May	Morn.	91	77	49	58½	45	50½	58	36½	47½	1,660	1,49	3,00	2,51
	Aftern.				62	46	53	68	45	57				
June	Morn.	88	97	46	63	50	54½	64½	47	53	4,043	1,45	2,78	3,17
	Aftern.				67	53	57	77½	49	62½				
July	Morn.	71	29,13	41	65	53	59½	66½	52	57½	3,674	3,98	5,16	3,81
	Aftern.				68	57½	61	78	57½	67½				
Aug.	Morn.	83	28,89	48	69	57	62½	67½	50	58½	2,861	2,86	4,25	2,52
	Aftern.				73	59½	65	79½	61	70				
Sep.	Morn.	85	57	30	61½	48½	55	60	41½	50	3,977	2,66	5,53	3,93
	Aftern.				63½	50	56	68½	48	58				
Oct.	Morn.	97	72	34	58	46	49	57	35	45½	1,756		5.55	4, 6
	Aftern.				59	46	50½	66	46	52				
Nov.	Morn.	91	78	52	51½	40½	46	50½	31½	42½	0,761		1,65	90
	Aftern.				53	39½	46½	56	37½	47				
Dec.	Morn.	85	50	31	48	36	41	52	29	39	2,723		2,11	1,40
	Aftern.				41½	36	42	54	31	41½				
											29.402		48.56	32.84

"The winter was a ſevere one; there was a ſharp froſt every month from December to March, chiefly between the full and the new moons, and the intervals were often ſtormy and wet; but thoſe in February, both at the middle and latter end of the month, were milder, and leſs wet. The beginning of March continued mild, with frequent though ſmall rains; then followed as ſharp a froſt, for a week, as any in the winter. After that ſtormy weather in April, but warm and growing; till a violent thunder ſtorm towards Stamford the 13th, and two days continued rain here, and in moſt other places, about the 18th, renewed the wet ſeaſon; which laſted all ſummer, and was perhaps wetter in many places than here, for we had no heavy thunder ſtorms all the ſummer, as they had in ſome parts. Whenever there was thunder this year, it was almoſt always cold after it, and often cold weather without it; very little ſunſhine, and many ſharp froſty mornings both in May and June, which cut off the apples after they appeared to be ſet. The greateſt rains this ſummer were after the middle of April; before the middle of May; about the 8th of June; the 21ſt of July; the 18th of Auguſt; and 14th of September: thoſe in April, June, and July, made floods, the two latter of which did great damage to the meadow hay; and there were frequent, ſometimes almoſt daily, leſſer rains. The intervals of fair and fine weather were ſhort, and not many, and thoſe not always warm; the beginning of May, and about the 21ſt; the beginning and end of June; the beginning of July; and, what was the fineſt time this ſummer, the firſt half of Auguſt. During this, in general ſo very wet a ſeaſon, the hay and harveſt were got in, and, where they were not flooded, I think with leſs damage than might have been expected. The latter hay was got up during the fine time in Auguſt; ſome of the harveſt in a tolerable time the beginning of September; and what was delayed by the almoſt daily rains for two-thirds of September, was finiſhed in a fine time the beginning of October; the crop of wheat was tolerable well, but barley, oats, and peas, were dear.

"This year was the wetteſt ſince 1782, which, with 1774, and ſome others, exceeded it; and this, like thoſe two years, began to grow leſs wet the beginning of October. Yet the frequent rains after that, though leſs in quantity, kept the ground from drying, which was already too wet, and the roads continued uncommonly torn up all winter; and December being wetter, increaſed it. The laſt ſix weeks of the year were in general dark and cloudy, or miſty; very little ſun, and not much froſt, and ſo far ſeems to promiſe an open winter; but December was a ſtormy time; ſeveral great ones, and ſome great rains and floods."

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PAPERS IN AGRICULTURE.

WILLIAM PATTENSON, Eſq. *of Ibornden, Kent*, communicates a method of preſerving young plantations from being injured by hares and rabbits gnawing the bark. Theſe animals have an averſion to tar; but this fluid, when long expoſed to the air, acquires a dryneſs, which occaſions the tree to which it is applied to be bark-bound. The method, then, is to mix the tar with ſix or ſeven times as much greaſe, and with this compoſition to bruſh the ſtems of young trees as high as hares, &c. can reach, which proves an effectual preſervative. Flowering ſhrubs, to which the mixture cannot be ſo conveniently applied, may be preſerved by encloſing the branches with ſeveral turns of new tarred twine.

Thomas Skip Dyot Bucknall, Eſq. obtained the ſilver medal for his obſervations concerning the pruning of orchards. He remarks that the bark of trees is of three kinds; the outer, rough; the middle, ſoft and ſpungy; the inner, a whitiſh rind, connecting the bark to the wood. When the ſtem grows too faſt for the bark, it cauſes blotches and lacerations, which evil is cured by ſcoring the bark with a ſharp knife; but care ſhould be taken not to cut through the inner rind, which heals with difficulty, and is apt to become ulcerated, admitting inſects to get between the wood and the bark. The great principle of pruning, is to admit the ſun and air freely to the tree, and prevent branches from croſſing, ſo as to injure one another when moved by the wind. The more circularly the range of branches is diſtributed, the better, on account of the more equal circulation of the ſap. Shortening the branches is not neceſſary except on account of the ſhape of the tree; and when it is done, they ſhould be taken off cloſe at the diviſion, in order that the wound may the ſooner heal. Upon theſe general principles Mr. Bucknall ſtates his operations in recovering to a healthy ſtate an orchard of one of his tenants, conſiſting of ſix acres fully planted with apple and cherry trees, which from neglect had become greatly cankered and decayed. The tenant thus deſcribes the proceſs. " The progreſs was thus: we ſtood and examined the tree, then cut out every branch any way decayed or galled, or where there appeared any curled leaves. That being done, we thinned the tree to give it an uniform head, and that the air and ſun might freely paſs through: afterwards, we took off all the ſtumps which had been injudiciouſly cut before. We never ſhortened a branch, but took it off cloſe to where it ſhot out from the other part of the tree.

" Mr. Bucknall conſtantly attended, and was determined that we ſhould cut cloſe, ſmooth, and even, holding the left hand under the branch, that it ſhould not ſhiver the bark. We alſo took off every branch which croſſed the tree, leaving none but thoſe whoſe extreme branches tended outwards. We were ſometimes in doubt whether a branch ſhould be taken off or not. The rule Mr. Bucknall eſtabliſhed was, Conſider, will that branch be in the way three years hence: if it will, the ſooner it is off the better; and it is ſurpriſing how ſoon we got into ſuch a method, that we went on with as much unconcern, as with any of the common labours of the field. A ſervant was employed to ſmooth, with a knife, all the places where the ſaw had been, and to rub them over with the medicated tar; and that was done directly, that the wind ſhould not dry or ſplit the wood. Formerly, when we uſed to take off a large branch or two, the wounds generally cankered; which made us leave them in the encumbered ſtate they were in, rather than run any hazard; but, to our great ſurprize, the wounds, after this operation, all healed; which we can no otherway account for, but from what Mr. Bucknall ſays, that the medication deſtroys the vermin, and by cutting quite cloſe to the remaining branch, the flow of the ſap draws the ſides of the wounds together. Be that as it may, the trees are perfectly healed; and we are ſo well ſatisfied, that we intend to thin ſome of the trees a little more next autumn, and ſtrongly recommend the practice."

The medicated tar alluded to was made by diſſolving a quarter of an ounce of corroſive ſublimate reduced to fine powder, in a glaſs-full of gin, in a three-pint earthen pipkin, and then filling by degrees the pipkin with common tar, ſtirring it well to make the mixture thoroughly incorporate. This quantity is ſufficient for 200 trees.

Four papers, containing accounts of the comparative culture of wheat, are next given. The firſt is that of *Mr. Arthur Tabrum, of Aveley in Eſſex*, who gained the premium, his being the largeſt quantity cultivated. On compariſon of ſix acres drilled with Cooke's machine at nine inches, and the ſame quantity broadcaſt, the produce of the former was 20 buſhels 1 gall. of corn per acre, and of the latter, 19 buſhels per acre; and the ſtatement of pecuniary advantage in favour of the drill is as follows:

	£.	s.	d.
Seed ſaved per acre, at 6s. per buſhel - - -	0	9	0
Superior crop ditto - - - - -	0	5	4½
More ſtraw ditto - - - - -	0	1	9
Better quality of grain, ditto - - - -	0	5	0
More labour beſtowed on the broadcaſt crop, per acre -	0	1	4
	1	2	5½

The better condition in which the ground was left after the drill crop is further eſtimated at £1 per acre. Mr. Tabrum conceives early ſcarifying to be eſſential to the ſucceſs of the drill huſbandry.

Of the other experiments, the ſucceſs was various; but in general the preference is given to the drill.

Joſeph Sibley, Eſq. of Market-ſtreet, Hertfordſhire, communicates the reſult of an experiment on the tranſplanting and dividing the roots of corn, by which it appears, that a grain of wheat, tranſplanted, but with the roots not divided, produced 100 ears, containing 2000 grains; another, the root of which was divided into ten parts, produced 90 ſtalks and ears, but the number of grains could not be aſcertained, as the birds had carried away moſt of them.

Mr. Peter Smith, of Hornchurch, Eſſex, who obtained the premium for ſtall-feeding horſes with green vegetables, gives the following account of his experiments.

"From the 21ſt of April, 1792, to the 22d of September following (twenty-two weeks), I kept four horſes in the ſtable on green rye, winter and ſummer tares; rye, two roods and two perches; winter tares, one acre, one rood and ten perches; ſpring tares, two acres one rood and ſeventeen perches, one rood of which was left unconſumed: conſequently, the whole quantity of land on which theſe green vegetables were produced, amounts to three acres three roods and twenty-nine perches. The expence as follows:

	£.	s.	d.
One ploughing after wheat, at 6s. per acre	1	3	7½
Seed	2	16	0
Harrowing	0	1	3
Rent and Taxes	3	19	0
	£.7	19	10½

Which, omitting the fractions, is one ſhilling and nine-pence three farthings per week for each horſe. This, I believe, would have ſupported my horſes, at common farmers work, with little or no corn; but as they did nearly double work, I gave an extra quantity of corn, viz. fifteen quarters five buſhels, which I value at fourteen pounds ſixteen ſhillings and ten-pence, or three ſhillings and three-pence farthing per week, each horſe.

"If my horſes had been at graſs in the field, I ſhould have given them the ſame quantity of corn, on account of their hard work. One of the advantages of ſtall-feeding conſequently appears from the difference of the value of the food conſumed compared with the value of common graſs, which is near one hundred per cent. in favour of ſtall-feeding; the expence of green food being, as above ſtated, one ſhilling and nine-pence three farthings per week, each horſe: but if my horſes had been at common graſs, I ſhould value their keep at three ſhillings and ſix-pence, or four ſhillings per week, each horſe.

"From the time I began to keep my horſes with green vegetables, as above, to the laſt week in Auguſt, they were in a thriving ſtate: afterwards, they did not ſo well, on account of the wetneſs of the ſeaſon, which mildewed the tares. During the above twenty-two weeks, my horſes had no reſt whatever on working days. The firſt month they carted dung from Romford, three journeys a day, of ſeven miles per journey; the loads of dung, from two and a half to three tons per load: the remainder of the time, they went three times a week to London with ſtraw, and brought dung and chalk rubbiſh back; each journey, thirty-three miles: the other days, at plough, ſcarifying, ſcuffling, fallows, hay-cart, harveſting, and other work on the farm: the weight of the dung obtained from my own horſes, during the ſtall feeding, was eighteen tons, one hundred, one quarter and ſixteen pounds, calculated from the produce of ten weeks, weighed at ten ſeparate times. I have charged nothing for the carter's time in cutting the green food, as it came within his day's work; and they were carted home by the ſame horſes that conſumed them, as much at one time as would laſt two days."

Mr. William Hollins, of Berriew in Montgomeryſhire, to whom part of the premium for diſcovering the cauſe and cure of the curled diſeaſe in potatoes was adjudged, communicates his experience for the prevention of it. He ſuppoſes the principal cauſes to be, 1. from potatoes being forced by cultivation to overgrow their power for vegetation; 2. from their vegetative power being dried up in ebb ſoil by the ſcorching heat of the ſun; 3. from their being expoſed too long, after they are cut into ſets, before they are planted. His directions for the cultivation are as follow.

"In cutting potatoes for ſets, care ſhould be taken not to cut them entirely through; but when the knife had penetrated to about the half, the other half ſhould be ſliced or broken off. By this operation you may underſtand whether the potatoe has proper vegetative power or not; if the knife enters eaſily, and the potatoe breaks off ſoft, then it is fit for ſeed: but if, on the contrary, the knife enters with ſome difficulty, and the potatoe breaks off harſh and rough, though it may not appear to want ſap, yet it is void of proper vegetative power, and unfit for ſeed; for if planted, it will either remain whole in the ground till dug, or produce a complete curled crop. However, if made uſe of as food, it will boil ſome minutes ſooner, and eat drier and mealier than a ſound potatoe.

" Regard ſhould always be had to the nature of the ſoil where potatoes are to be planted: wet heavy ſoil will ſtarve and rot them, in the ſame manner as it will ſcald and ſtarve any kind of grain, eſpecially in a wet ſeaſon; and alſo ſharp ebb ſoil, where there is not ſufficient mould to protect them from the ſcorching heat of the ſun, will dry up the vegetative power, in the ſame manner as it will cauſe any kind of grain to wither and die away, particularly in a hot ſeaſon.

" Care ſhould alſo be taken not to plant them in unprepared ground and freſh manure; for I have found by repeated experiments, that freſh manure is a great detriment to the potatoe, when ſet in it; as in ſome kind of ſoil, and in ſome ſeaſons, it will cauſe even a ſound plant to curl in ſome degree; but ſhould the plant be in the leaſt unſound, the whole crop will be entirely curled, becauſe the heat of the manure dries up the vegetative power. Preparing the ground in time, likewiſe, will be a great means towards killing the weeds, which not only injure the potatoe much, but impoveriſh the ground alſo.

" The beſt method of managing the ground, in my opinion, is the following: plough it in the beginning of January, and, in a month's time, or ſooner if the weather permits, harrow it, and manure it well on the ſurface, as you would for turneps; then plough it in, and let it lie till the middle of April, by which time the froſt will have tempered the ground, and the manure will be rotted; then plough it acroſs and harrow it; and after that ridge it up, and plant your ſets, care always being taken that there is ſoil in the bottom of the furrow.—Thus you will not only inſure a good crop of ſound potatoes, but alſo have your ground much better prepared for wheat, than by ſummer fallowing."

William Barbor, Eſq. of Fremington, Devonſhire, to whom the premium for feeding cattle and ſheep with potatoes was adjudged, gives a ſtatement of their tillage and the expences and profits. He planted 24 acres with potatoes after three methods, and with three kinds of manure, at the ſeveral expence of £3. 7*s*. 3*d*. £3. 4*s*. 1*d*. £3. 7*s*. 9*d*. per acre. On 20 acres of theſe he fed 56 bullocks; the other four he uſed, cut in ſlices, as fodder to young cattle. They had a little hay at firſt, and afterwards ſtraw, which however is conſidered as compenſated by the dung. The clear profit of the cattle on ſale was £200. Each bullock on an average eat three pecks of potatoes a day, which, at the rate they then ſold at, was 2*s*. 6*d*. per week.

Mr. James Bucknell, who cultivated 16 acres, 3 roods, of land with potatoes for feeding cattle, found in general that with the help of this food he could keep a greater number of cattle and ſheep in a thriving ſtate, than by any other means. His method of culture is by planting the potatoes with the plough in every third furrow, and when they appear above ground, earthing them up by means of a plough going between the furrows.

Mr. Smith, of Hornchurch, gives an account of a comparative experiment in cultivating turneps by the drill, and the broadcaſt method, for which he obtained the Society's premium. A field equally divided, was ſown half with Cooke's drill, at one pint of ſeed per acre, and half broadcaſt, at one quart per acre. The produce of ſix roods drilled was 16cwt. 1qr. 7lbs; of the ſame quantity broadcaſt, 14cwt. 2qr. 9lbs. At the price at which they were ſold, the preference of the drilled, including 2*s.* 4*d.* ſaved in hoeing, is 15*s.* 4¾*d.* per acre.

The culture of rhubarb is the ſubject of the next paper, written by *Mr. Thomas Jones,* to whom the premium was adjudged. After preparing a piece of ground of a light and rich ſoil by ploughing, and then ſowing with turneps, he cauſed every ſpot where he intended to plant a root, to be dug about three ſpit deep, and the ſurrounding earth to be heaped upon it to a conſiderable height, forming a diſtinct hill for every plant. His reaſons for this practice were, that the rhubarb roots ſhould have a great depth to penetrate, and that the earth ſhould lie light about them, while they are both preſerved from the effects of froſt, and of too much moiſture, which the leaves are very apt to collect. The diſtance between the plants was ſix feet. The ſeed was ſown on a ſtratum of fine mould over dung, under a melon frame. He found the proper ſeaſon for ſowing to be in ſpring about March and April, or in autumn about Auguſt and September; the plants raiſed in one ſeaſon, to be tranſplanted in the other. Their ſituation, he thinks, can ſcarcely be too dry and warm.

Mr. Thomas Halley, of Pontefract, ſent the Society ſome ſamples of rhubarb, ſome of which appeared to be ſuperior to any hitherto cured in England. The prime roots were ſevered in ſmall pieces, peeled clean, and thoroughly cleared from unſound particles. Part was ſeparately laid in ſieves, and part ſtrung, and hung from the ceiling of a warm kitchen. They were dreſſed by paring off the external coat with a ſharp knife as thin as poſſible, and then finiſhing off by a piece of fiſh-ſkin, with powder of the roots, procured from the chips.

Charles Haſſel, Eſq. of Eaſtwood, Pembrokeſhire, obtained the premium for improveing waſte moors, of which he brought into cultivation 330 acres, at the average expence of £3. 17*s.* 1*d.* per acre. The proceſs was by grubbing, burning, and liming.

The premium offered for an improved hoe was adjudged to *Mr. James M'Dougal, of Great Windmill-Street.* (See Plate IV. Fig. 3.)

Mr. Henry Browne, of Derby, recommends as an effectual method for preventing the deſtruction of ſeeds by vermin, the practice of ſteeping the ſeed for three or four hours, or long enough to penetrate the huſk, in a ſtrong ſolution of liver of ſulphur.

PAPERS

PAPERS IN MANUFACTURES.

A Bounty of Fifteen Guineas was given to *Mr. Robert Burt, of Burnham, near Maidenhead, Berks,* for his contrivance to be added to the common Spinning-Wheel, whereby the Spinner is enabled, at the ſame time ſhe is ſpinning, to wind off a ball of thread, without any ſenſible addition of labour.

" This contrivance was principally intended for winding thread for the uſe of ſhoemakers, but may be applied to other purpoſes; and a ſpinning-wheel, with theſe additional parts, is reſerved in the Society's Repoſitory, for the inſpection and uſe of the public. As the Society have, this year, judged proper to offer a premium for the beſt drawing, by youths, of Mr. Burt's Spinning-wheel, a plate of it cannot properly be inſerted in this volume, but may make part of ſome future publication."

Improvement on the Spinning-Wheel. By Mr. ANTIS.

TWENTY Guineas were giving to *Mr. John Antis, of Fulneck, near Leeds,* for his ingenious method of cauſing the bobbin of the common Spinning-wheel to move backward and forward; by which means, the time loſt by ſtopping the wheel, to ſhift the thread from one ſtaple, on the flyer, to another, as has hitherto conſtantly been practiſed, is avoided; the danger of breaking the thread and looſing the end, obviated; and the ſpinner enabled to do much more work, in a given time, than by any common ſpinning-wheel hitherto in uſe.

" The method of cauſing the bobbin to move backward and forward (which is the improvement here meant to be ſhown) is effected by the axis of the great wheel being extended through the pillar next the ſpinner, and formed into a pinion of one leaf, A, which takes into a wheel, B, ſeven inches diameter, having on its periphery ninety-ſeven teeth; ſo that ninety-ſeven revolutions of the great wheel cauſe one of the leſſer wheel. On this leſſer wheel is fixed a ring of wire, *c c c*; which, being ſupported on ſix legs, ſtands obliquely to the wheel itſelf, touching it on one part, and projecting nearly three quarters of an inch at the oppoſite one; near the ſide of this wheel, is an upright lever, C, about fifteen inches long, moving on a center, three inches from its lower extremity, and connected at the top to a ſliding bar, D; from which riſes an upright piece of braſs, E, which, working in the notch of a pulley, drives the bobbin, F, backward and forward, according as the oblique wire forces a pin G, in or out, as the wheel moves round. To regulate and aſſiſt the alternate motion, a weight, H, hangs by a line to the ſliding bar, and, paſſing over a pulley, I, riſes and falls, as the bobbin advances or recedes, and tends conſtantly to keep the pin in contact with the wire. It is evident, from this deſcription, that one ſtaple only is wanted to the flyer, which, being placed near the extremity, K, the thread paſſing through it, is, by the motion of the bobbin, laid regularly thereon." (See Plate IV. Fig. 1.)

Deſcription of a Gudgeon, on an improved Conſtruction, for the upright Shafts of Mills. By Mr. STEPHEN KENDRICK.

" THIS gudgeon is formed of hard ſteel, and works on a hard ſteel bed; is circular, three inches diameter, and three-fourths of an inch thick; from its upper ſide a rib projects, which, being fixed in the bottom of an upright ſhaft, the gudgeon works horizontally on a ſquare bed: and that now in the poſſeſſion of the Society has worked in a mill whoſe wheel and ſhaft weighed nearly ſix tons; and, though it had continued in work ſeven years, had loſt very little of its ſurface. It ran in a ſquare box of caſt iron, having oil therein: and a notch along the whole of the face of the gudgeon admits the oil to inſinuate itſelf between the gudgeon and the bed."

Deſcription of a Pentrough, for equalizing the Water falling on Water-wheels. By GEORGE QUAYLE, *Eſq.*

TO inſure a regular ſupply of water on the wheel, and to obviate the inconveniences ariſing from the uſual mode of delivering it from the bottom of the pentrough, this method is deviſed of regulating the quantity delivered by a float, and taking the whole of the water from the ſurface.

" Section of the Pentrough. Plate IV. Fig. 2. No. 1. A, The entrance of the water. B, the float, having a circular aperture in the center; in which is ſuſpended C, a cylinder, running down in the caſe E, below the bottom of the pentrough. This is made water tight, at the bottom of the pentrough, at F, by a leather collar placed between two plates, and ſcrewed down to the bottom.

" The cylinder is ſecured to the float ſo as to follow its riſe and fall; and the water is admitted into it through the opening in its ſides, and there, paſſing through the box or caſe E, riſes and iſſues at G, on the wheel. By this means, a uniform quantity of water is obtained at G; which quantity can be increaſed or diminiſhed by the aſſiſtance of a ſmall rack and pinion attached to the cylinder, which will raiſe or depreſs the cylinder above or under the water line of the float; and, by raiſing it up to the top, it ſtops the water entirely, and anſwers the purpoſe of the common ſhuttle. This pinion is turned by the handle H, ſimilar to a winch-handle; and is ſecured from running down by a ratchet wheel, at the oppoſite end of the pinion axis.

" K and L are two upright rods, to preſerve the perpendicular riſe and ſinking of the float, running through the float, and ſecured at the top by brackets from the ſides.

" M, a board let down acroſs the pentrough, nearly to the bottom, to prevent the horizontal impulſe of the water from diſturbing the float.

" No. 2. A croſs ſection, ſhowing the mode of fixing the rack and pinion, and their ſupports, on the float. The rack is inſerted into a piece of metal running acroſs the cylinder, near the top. That the water may paſs more freely, when nearly exhauſted, the bottom of the cylinder is not a plane, but is cut away ſo as to leave two feet, as at C, No. 1. The float is alſo kept from lying on the pentrough bottom, by four ſmall feet; ſo that the water gets under it regularly from the firſt.

" No. 3. An enlarged view of the cylinder, ſhewing the rack and ratchet wheel, with the click, and one of the openings on the ſide of the cylinder: the winch, or handle, being on the oppoſite ſide, and the pinion, by which the rack is raiſed, incloſed in a box between them. The ſcale of the model is one inch to a foot. The annexed figures are reduced to one ſixth."

Deſcription of Mr. JOHNSON's *double-gibbed Crane, for laying a Weight to any Part between the Range of the Gib and three Feet of the Center of the Crane.* (See Plate III. Fig. 1.)

"A, The weight ſuſpended. B, the upper block moving on the top of the gib, and drawn backward or forward by two ropes. GG, winding in different directions on an arbor at H. The weight and lower block are raiſed or lowered by a rope, winding on or off the axis C; and the power is increaſed by a rope winding round a large wheel D, fixed on the axis C, which is wound round an arbor, turned by a winch at F. To turn the gib to the right or the left, there are two arbors turned by winches at I I: round theſe arbors, ropes from the extremity of the gib K K, paſſing through proper ſnatchblocks, are wound; the one of the ropes being ſlackened, while the other is drawn in according to the movement intended; and thus the horizontal motion of the whole gib is obtained, and the weight A may be depoſited on any ſpot required, within the range of the gib. Two friction wheels are placed on each ſide the upper block, which not only ſerve to clip the top of the gib, and thus prevent the block, by any accident, ſlipping off, but facilitate its motion along the upper part of the gib."

A Plan to prevent a Ship's Rudder being loſt, ſhould the Pintles or Braces, on which it moves, be entirely broken, and to prevent a Rudder beating about in caſe the Tiller is broken.

THIS plan is calculated to ſave the rudder when it is beat off, and to keep it in its proper place; for, as the iron work cannot withſtand the violence of the ſhip's ſtriking the ground, the fid, when the iron work is carried away, will ſtill ſupport the rudder by reſting on the comings, and act as an upper gudgeon. If the rudder ſhould be beaten off, additional rudder pendants are recommended; which is eaſily done by clinching hawſers round the rudder on each ſide of the ſhip, and ſlipped well down the rudder, to keep the lower part as quiet as poſſible.

Should the tiller be carried away in a gale of wind, it is propoſed that the coming, which incloſes the head of the rudder, ſhould have holes bored at convenient diſtances to receive bolts or palls between two and four inches in diameter, and about fifteen inches in length, according to the ſize of the ſhip: theſe bolts being placed on each ſide of the fid, when occaſion requires, will confine the helm in any poſition, and not only give an opportunity of ſhifting a tiller, but of taking off any ſtrain from it when lying to.

" Explanation of the plate of *Captain Pakenham's* Rudder. A, a ſquare fid made to fit the upper hole of the rudder, and bolted through the rudder head. B, a coming, fitted round the rudder-hole, and well ſecured to the deck, for the fid to work on, and acting as an upper gudgeon, in caſe the pintles are beaten off. C, palls bolted through the fore part of the coming, to quiet the rudder, in the room of chocks, in caſe the tiller ſhould be carried away." Plate II. Fig. 2.

Obſervations on throwing a Gun Harpoon. By JOHN BELL, *Serjeant in the Royal Artillery.*

"FIRST, in order to ſtrike an object, at the diſtance of about ſixty feet, requires no leſs an angle than five degrees elevation; from which the gun's poſition then is ſuch as wholly to obſtruct the perſon uſing her, from pointing out any true line of direction; likewiſe the proper elevation can be no other than a ſuppoſition.

" To remedy this, a tangent diſpart is permanently fixed at the muzzle of the gun. The vertical lines ſhow the line of direction; and the horizontal lines, the required elevation; which is explained in the following manner, viz. The front horizontal line, and the under part of the rear cut, and the baſe ring of the gun, are parallels; ſo that an object ſeen upon the ſame level with the metal, would be ſtruck with the harpoon at about thirty feet diſtance: then the coin being drawn back, until the under horizontal line of the rear cut interſects the front line and the object, it would then be ſtruck at the diſtance of about ſixty feet; and when the upper line of the rear cut interſects the front line and the object, it would be ſtruck at the diſtance of about ninety feet: ſo that any intermediate diſtance between thoſe mentioned, muſt depend on the perſon's judgment in uſing the gun. For inſtance, ſuppoſe the diſtance to be from 70 to 80 feet; then bring the front line and a middle ſpace between the two rear lines and the object in view. The ſame rule muſt be obſerved for any diſtance under ſixty feet.

" Secondly, Appropriating two locks inſures a more certain fire; and ſhould both locks take, the powder muſt be more equally inflamed.

" Thirdly, Coiling the line in the front locker prevents it from getting entangled; likewiſe, in traverſing the gun to the right or left, as occaſion may require, the line is moved with it; which alſo prevents the harpoon, in its flight, from being influenced by the weight of the line out of its proper direction; which muſt otherwiſe be the caſe, where the line lays upon one ſide of the metal. From this it may not be improper to obſerve, that, in nearing the intended object, attention ſhould always be paid, to endeavour, as much as poſſible, to be ſo ſituated, that the wind blows either a-head or ſtern of the boat at the time of firing; for a ſtrong wind will ſenſibly alter the harpoon's line of direction, from the power it has upon the line, as its length increaſes from off the locker. The two ſmall pins at the front of the locker are to keep the coil in (on a rough ſea), which are to be thrown out before firing: but ſhould this be neglected, no other damage will enſue, than bending the pins a little, by the friction of the ropes running out.

" Fourthly, From experiment, it is found, that the gun, when loaded with twelve drams of powder, and a harpoon weighing between five and ſix pounds, is fired, the re-action upon the metal is conſiderably more violent than when loaded with a ſervice charge of powder and ſhot. In order to prevent any accidents which might happen, by the iron pin of the carriage giving way, from ſo ſudden a ſhock, a breechen is made faſt, from the ſliding carriage, to the head of the boat, and properly ſecured: the gun being fired, the elaſticity of the breechen permits her to recoil about two inches, which certainly is a much leſs ſtrain to the boat, and a ſafer method of uſing the gun; for, allowing the breechen to break, there is then the ſame principle of the iron pin to be depended upon, as at preſent.

" Fifthly, the wooden tube which encircles the ſhank of the harpoon, is driven off from the muzzle of the gun, on the firſt impulſe; ſo that the line can receive no injury from the fire; and the harpoon meets with but a ſmall check, from the collar and ſhackle, and of courſe muſt preſerve in its flight a more uniform line of direction, and angle of elevation.

" Sixthly, Attention ſhould be paid to keep the powder in good order. If a doubt ſhould ariſe of that nature, place a ſmall portion of it on the hand; and if, in ſhaking it off again, a quantity of duſt remains on the ſkin, it indicates the powder having imbibed moiſture. To remedy this, take a clean glazed earthen pan, and warm it upon a fire, ſo that the hand can bear to touch it; then wipe it, and remove it to a proper place, throwing a few ounces of powder into it; which will in a few minutes become dry; conſequently, will act more quick and violent.

"Deſcription of the Plate of Mr. *Bell*'s improved gun and harpoon. Plate III. Figure 3. No. 1. The gun fitted for firing. No 2. The form of the harpoon. The head of this harpoon, A, is of the uſual ſhape; from whence runs a ſhank B, terminating, at the other end, in the form of a cylinder ſhot. A piece of aſh, or other wood, *cc*, is turned, of a due ſize, and length of the bore, to fill the calibre of the gun when the charge is in; and, being ſawed in half, lengthways, a hollow is ploughed in each piece, to clip the ſhank of the harpoon: thus the whole bore of the gun is filled; and, on the diſcharge, the ring to which the rope or fore-ganger is affixed, ſtrikes againſt the cylinder ſhot, with its force ſo much abated as to prevent any danger of breaking the ring."

A Contrivance for locking Carts in deſcending ſteep Hills. By THOMAS COLLEY, *of Gregynog, near Newtown, Montgomeryſhire.* (See Plate I. Fig. 9.)

"A, The hollow, which lies on the nave of the wheel. B, C, The chains which clip the felly of the wheel. D, The front part of the pole, ſhod with iron. To ſtrengthen the pole, a rib of iron is alſo rivetted along the ſide of it, as expreſſed by the black line. When the chain C is put round the felly of the wheel, the pin at B being paſſed through the outermoſt link of C, and turned back through the moveable ring, *e*, the wheel is thus held faſt."

This locking pole to be ſecured from breaking, ſhould be made of aſh, which grew near its form, particularly at the lower end, and ironed as the model. The butt or ſtem of an aſh tree, having the ſpurns or beginning of the roots, left to it in felling, is beſt fitted for this purpoſe. It is to be obſerved, that if a horſe is put into the ſhafts, that has been uſed to that ſituation and to deſcents, he will be ſo much inclined to hold back, that it will be found difficult to make him draw; which ſhould he not do, the chain horſe who ſhould always be linked to the locked ſide, will have too much to draw. To convey the locking pole, it is placed between the underſide of the cart and the axle-tree, and the ſmaller end buckled with a ſtrap.

A Contrivance by Means of a Preſervative Wheel to be fixed to a Walking Wheel Crane, for inſuring the Safety of the Men, ſhould the Weight at any Time overcome the Power. By JOSEPH DIXON, *Moore's Yard, Old Fiſh-ſtreet.* Plate III. Figure 2.

"A, A. The axis or ſpindle of the walking wheel. B B. Two preſervative wheels fixed on the axis, and having near their peripheries ſix pullies, over which ropes run, that are faſtened, at their extremities, to two ſegments of circles C C. Theſe are united together by a wooden bar D, which the men are to lay hold of, as expreſſed in the figure, and ſuſpend themſelves by, in caſe of danger."

PAPERS IN COLONIES AND TRADE.

TWO letters from *Dr. Dancer of Jamaica* give brief accounts of the growth of new plants there, as the Ché, or Oldenlandia umbellata, and eſpecially the true cinnamon, which is beginning to be largely cultivated in that iſland, one gentleman having already planted out fifty thouſand trees.

Some ſubſequent letters relate to the culture of the Ceylon cinnamon at Madraſs, firſt introduced by Mrs. Anſtey, and at preſent in a flouriſhing condition.

Fig 1

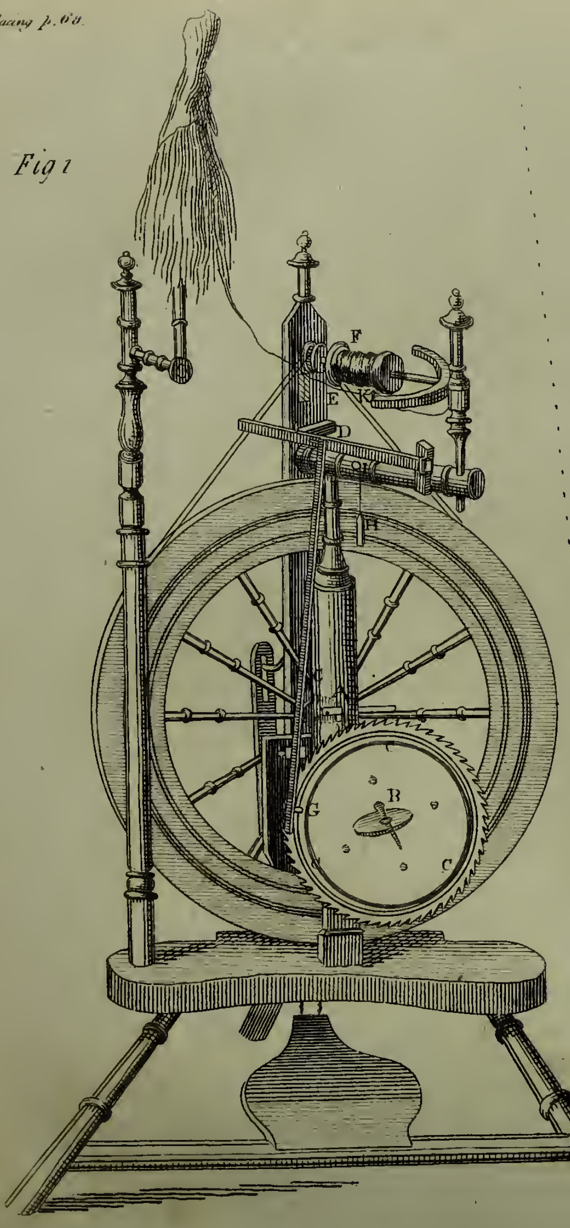


Fig 2

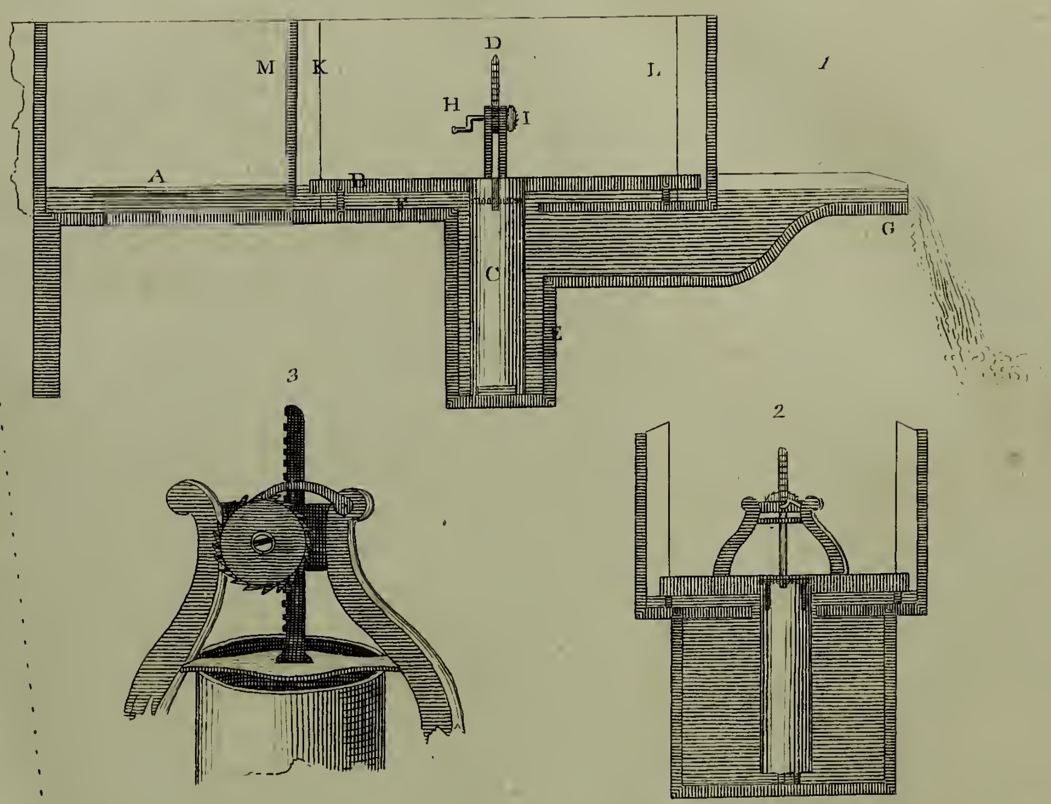
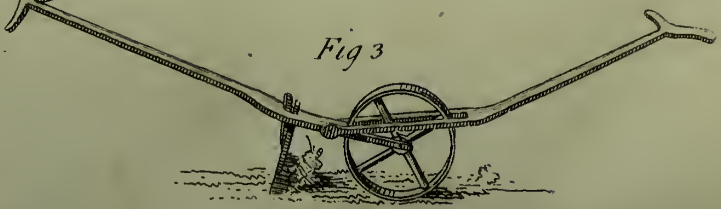


Fig 3



Obſervations and Diſcoveries of a Society of Natural Philoſophy at Berlin.

I. *Mineralogical and Chemical Obſervations on ſome Siberian Lead Ores. By* MR. BINDHEIM, *Apothecary in Moſcaw.*

I.

Of a brown Lead Ochre from the Klitſchenſkoi Mine at Nertſchinſki.

IS of different colours: externally blackiſh and yellowiſh-grey, and brimſtone-yellow; internally yellowiſh-brown and liver-brown interſperſed with ſilver coloured grains of various ſize. Its external ſurface generally unequal and rough. Internal ſurface ſhining, glittering, ſometimes dull and duſty.

Adheres to the tongue.

Is cold.

Specific gravity as 3,920 : 1,000.

Grains 100 contain.

Lead	35
Iron	14
Silver	1½
Pure earth of alum	3
Arſenical acid	25
Silicious earth	7
Water	10
	95½
Loſt	4½
Total	100

II.

Of a white ſparry Lead Ore from the Necolajewſki Mine.

Is of a yellowiſh white, bright white, and whitiſh grey colour.

Its ſhape kidney ſhaped, globular, ſometimes arboreſcent often cryſtallized.

Shape of the cryſtals undetermined, priſmatic pyramidical commonly long rectangular in 4 ſided priſmes, ſometimes cohering by their ſides.

Its ſpecific gravity is as 6,615 : 1,000.

100 parts contain

Lead	74
Carbonic acid	15
Carbonate of lime	1
——— of earth of alum	1
Silicious earth	¼
Oxyde of iron	¼
Water of cryſtallization	4
	95½
	4½
Total	100

III.

Of a grey tranſparent ſparry Lead Ore from the Ildekanſkiſchen Mine, near Nertſchenſki.

Is of a blackiſh grey, inclining to an iron grey.
Externally ſhining, ſometimes glittering.
Internally ſhines ſtrongly.
Is tranſparent at its edges, and in ſome few places ſemitranſparent.
It is half hard, inclining more to the ſoft.
Cold and
Heavy as 6,103: 100.

100 parts contain

Lead	77½
Carbonic acid	15
Oxyde of iron	1¼
Silicious earth	½
	94¼
Loſt	5¾
Total	100

IV.

Of a vitriolated Lead Ore from the Socmanowſchen Mine, at Nertcſchenſki.

Is of a light yellowiſh grey colour, with greyiſh black veins hung in ſome places of a light reddiſh brown. Externally unequal and rough. Internally dull, interſected with ſmall flits. Is not tranſparent. Is a little adheſive to the tongue, and has a faint argillaceous ſmell.

Specific gravity 5144: 100.

100 parts contain

Lead	60
Vitriolic acid	20
Oxyde of iron	1
——— of antimony	4½
Calcareous earth	4½
Siliceous earth	5
Water and aërial acid	2½
	97½
Loſt	2½
	100

II. *Oryctognoſtic Remarks relating to the Hiſtory of Tin.* By ——— Karsten.

THE genus of tin comprehends only the three following ſpecies.

1. Tin pirites (*zinnkies*)

2. Tin ſtone (*zinnſtain*)
3. Corniſh tin

The tin pyrites is of a ſteel grey colour and ſolid, of unequal fracture, and the fractured pieces of no regular angular ſhape. It is perfectly opake, ſoft, and mild, cracks eaſily, and is heavy.

It is as yet only to be found in Wheal Rock in the Pariſh of Cornwall.

According to Klaproth, it contains 34 parts of tin, 36 copper, 25 Sulphur, 3 iron, and 2 of earth. Specific gravity according to the ſame authority, is to water as 4350 : 1000.

Tin ſtone, Blackiſh and reddiſh brown, ſometimes yellowiſh and aſh-grey; ſolid, finely interſperſed. Cryſtallized in rectangular, four ſides priſms, and double four ſided pyramids.

On fracture, it is ſolid, unequal and ſmall grained.

It is found in Saxony, Bohemia, Cornwall, in the Scilly Iſlands, in Galleicia, in Lower Hungary, in Mexico, Chili, and in the Iſland of Bunka. Contains according to Kirwan 80 parts tin and iron.

3. *Corniſh tin, wood tin.* Striped of different ſhades of brown. Seems to break into 3 ſided pyramidical pieces, is very heavy, rather ſoft and fragile. Found at St. Denis, in Cornwall. Contains according to Klaproth, 63½ parts tin.

III. *Deſcription of a Conductor, which may be uſed as an Electroſcope. By* J. P. Pelisson.

See Plate VI. Fig. 2.

IN the beam D at the eaſtern end of the platform, on the top of the houſe is inſerted a glaſs tube E, fixed at the other end to the funnel of iron plate F, in which is inſerted the iron rod G, ſharp pointed, and having a vane K. From the bottom of the funnel hangs the metal ball I, to which another ball K is brought nearer or otherwiſe at pleaſure, by means of the joint L, and the electric matter is thus drawn off by the rod N N N. which is bent at the bottom round the northern part of the houſe, and carried eight or nine feet under ground, ſo that its end is always in the water.

A great advantage of this conductor is, that it reſts on an inſulated glaſs rod, by which method many accidents attending conductors in general are avoided. To make it a perfect electroſcope, the balls I and K need only be ſeparated, but care muſt be taken to rub off the duſt or ſpiders webs from the glaſs rod, that the inſtrument may be perfectly inſulated.

On the 18th of June 1788, by means of the fane at the top of the conductor, and another 215 feet off two ſtreams of air were obſerved, the one from the weſt, the other from the eaſt. * The ſtorm came on about four o'clock in the afternoon: about ſeven, when it lightened in the ſouth about four or five degrees above the horizon, the electroſcope gave ſparks of about a line, and continued to give them till eight o'clock, when they ceaſed, though the cork balls of the electrometer made a divergence of ten to fifteen degrees. The barometer was at 29..1½. Reaumur's thermometer between 21 and 22 degrees. On the 12th of July ſparks were obſerved of two to three lines. On the evening of the 24th of July was a great ſtorm, the balls were placed three lines from each other, and the noiſe of the ſparks was heard below in the garden. After one of the flaſhes of lightning, a train of fire nine or ten inches long was perceived to go with a ſlight hiſſing out of the ball I. From this appearance obſervers are properly cautioned not to ſtand too near the electroſcope, but to make their obſervations at a diſtance with a teleſcope.

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* The vane of the electroſcope is forty feet from the ground, the other vane above a hundred feet.

Beſides inſulating the conductors, ſome care ſhould be taken in placing them at a proper diſtance from each other. Buildings have been ſtruck at the diſtance of little more than fifty feet from a conductor; yet it is expected, that two conductors, one at each end ſhould preſerve a front of three hundred feet. From this prepoſterous conduct, the middle of the building is in greater danger than if there were no conductors at all. Hence alſo it is dangerous to reſide near a building with a conductor, and it were to be wiſhed that each houſe in a city was provided with one. A probable effect might be, that the air over the city being deprived of its electricity, a thunder ſtorm would never be heard in it, and if the Abbé Bertholoch's remarks are true, the neighbouring grounds would gain in fertility.

Perſons uſing conductors above deſcribed are cautioned to take away the electricity from the electroſcope, before they rub the glaſs, leſt during the friction they may run the riſque of receiving an electric ſhock.

IV. *Extract of a Letter from Mr.* Prevost, *to Mr.* Pelisson, *Feb.* 27, 1791.

AT times and particularly in ſpring and harveſt, when the ſky is very cloudy, and it rains by turns in various parts of the horizon, the wind appears to come from the quarter where it rains. The ſolution of this phenomenon ſeems to be, that every drop of rain brings down with it a portion of air, and though the quantity is but ſmall with each drop, the maſs collected by a ſhower, is a ſufficient cauſe for the effect above deſcribed.

The ſtrength of this wind depends on the number and velocity of the particles of air. The laſt has the greateſt effect. For as the magnitude of a drop of water does not depend on the magnitude of the body on which it hangs, ſo it is with the portions of air hanging on the drops of water. A large drop of water does not bring down a greater portion of air than a ſmaller one. The greater the number of drops, the greater will be the quantity of air brought down.

If we compare the drops of water hanging to any body, with thoſe of quickſilver, we ſhall find thoſe of water ſomewhat bigger. If the ſame analogy holds between water and air, a moderate rain will produce a wind, which ſufficiently anſwers the common obſervations.

Theſe remarks on the rain wind are derived from a converſation which the writer had with Montgolfier, at Geneva, and he leaves thoſe, who have leiſure, the application of them to ſimilar appearances.

V. *On the Revolution of Venus round her Axis, and two changeable Spots in the Moon.*

By Mr. Schroeter, *of Lilienthal.*

IT has been already proved, that the higheſt mountains of Venus, as well as the moon, are in the ſouthern hemiſphere, that their perpendicular heights are as the diameters of theſe planets, and that the mountain obſerved on the 28th of December, 1789, 1789, is four times as high as any in the moon, its perpendicular height being at leaſt 4,2 geographical miles.[*] By ſubſequent obſervations from the 11th of December to the 11th of January, theſe propoſitions have been fully confirmed, as the ſouthern horn of Venus appeared very much blunted, and with an enlightened mountain in the dark hemiſphere. On the 27th of December, the length of its ſhadow reaching to the illuminated hemiſphere, was to the ſemidiameter of Venus : : 1 : 8,25, and on the 30th of December the ſhadow appeared of ſuch a length that the height of the mountain muſt be 5,6 geographical miles.

Caſſini in the year 1666 concluded from the rotation of a point near the illuminated part, that Venus revolved about its axis in 23 hours, but he did not purſue his obſervations ſufficiently to determine, whether the motion might not be the effect of libration, as he did not afterwards diſcover ſimilar ſpots. In 1726, 27, 28, Bianchini from obſerving ſome ſpots in Venus, determined its rotation at 24 days 8 hours, but his were ſingle obſervations inſufficient, and interrupted.

From the obſervations already noted in the Selenotop. Fragmen. and others taken at every favourable opportunity on the different ſhapes of the two horns of Venus, I was convinced that Bianchini's conjecture was without foundation, Caſſini's nearly true, and that the period muſt be between 23 and 24 hours. For the appearance of the horns varied in a few hours, and at the correſponding time of the ſubſequent day was nearly the ſame. From the 11th of December, to the 11th of January, more exact obſervations were made, and the ſouthern horn, which was at firſt more blunt than the northern, in two hours loſt its ſhadow, became more pointed than the northern, and its blunted ſhape appeared every day above half an hour ſooner. Hence the period muſt be between 23 and 24 hours, the equator, conſiderably inclined to the ecliptic, and the pole at a conſiderable diſtance from the point of the horn.

It now remained to find the exact time of the rotation, and to do this, a mean was given on the 30th of December 1791, for on that day at eight o'clock of the morning, the ſouthern horn appeared with the ſame bluntneſs, and the with ſame illuminated mountain in the dark atmoſphere, that it had done two years before, on the 28th of December 1789, at five o'clock in the evening. From the obſervations above-mentioned between the 23d of December, and the 11th of January, the period muſt be between 23 hours, and 23 hours and 40 minutes; and after a calculation of the revolutions in 752 days, no period agreed ſo well as that of 23h..20′..59′,4.

This mode of calculating is evidently different from that of Caſſini and Bianchini, but it is remarkable, that in the memoirs of the Royal Academy for 1732, and in his elements of Aſtronomy, Caſſini has remarked, that the ſpots, from whence Bianchini drew his concluſion, were different, and that from his obſervations the period would be 23 hours 22 minutes.

In obſerving the moon on the 30th of December 1791, at five o'clock in the afternoon, with a ſeven foot reflector, magnifying 161 times, I perceived the commencement of a ſmall crater on the ſouth-weſtern declivity of the volcanic mountain in the mare Criſium.[†] Its diſtance from the illuminated part was at leaſt 6′..40″, and its ſhadow at leaſt 2″,5. At the ſame time I perceived in the above mentioned diſtrict, a ſimilar ſhadow two ſeconds in diameter, but notwithſtanding the great clearneſs, no traces could be diſcovered of a new volcano. On the 11th of January, at 20′ after five, on looking at this place again, I could ſee neither the new crater, nor its ſhadow. Probably this new volcano was became quiet again, and the ſmaller ſhadow was the appearance only of the atmoſphere, condenſed by a new eruption from a crater too ſmall to be perceived.

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[*] See Selenotop. Fragmenten. § 522.

[†] § 358 und Tab. xxxiii. der. fragm.

On the 4th of January 1792. I obſerved in the eaſtern crater of Helicon,* a central mountain of a clear grey colour three ſeconds in diameter, of which during many years obſervations, I had perceived no trace. This appearance is remarkable, as probably from the time of Hevelius, the weſtern part of Helicon has been forming into its preſent ſhape, and nature ſeems in that diſtrict to be particularly active. It is to be hoped that thoſe who in preceding years, have with good teleſcopes paid attention to this part of the planet, will favour the public with the reſult of their obſervations.

VI. *A Deſcription of two new Fiſhes.* *By* MARCUS ELIESER BLOCH.

A Drawing of both of theſe fiſhes was ſent to Dr. Bloch by Mr. Pennant, but as they were not coloured, they could not with propriety be introduced into his great work.

See Plate IX. Fig. 4. No. 1. (Pennant's Perch) This fiſh is eaſily diſtinguiſhed from the reſt of its ſpecies by the prolongation of the inferior part of the tail-fin.

Except the *Loricaria Cataphractus* and the *Fiſtularia chinenſis.* I know of no others poſſeſſed of ſuch a proceſs, and as in the firſt of theſe it proceeds from the ſuperior part of the fin, and in the ſecond from the middle, ſo theſe fiſhes cannot poſſibly be confounded with the one deſcribed. This fiſh is compreſſed on the ſides, the head ſcaly to the eyes, the aperture of the mouth wide, the lips broad, and each jaw rough and armed with teeth. The noſtrils are ſimple, and are placed in the middle between the mouth and the eyes. The rump is of equal breadth to the anal fin.

The lateral line begins at the covering of the gills, and approaching the back, makes a ſlight arch; but at the termination of the dorſal fin it is ſtrongly bent, and at laſt loſes itſelf in the tail fin.

According to the drawing there appears to be ſixteen radii in the pectoral fins, in the anal one ſeventeen, in the tail one eighteen, and in the dorſal one two and thirty.

This fiſh was ſent to Mr. Pennant from Gibraltar, where it is commonly found about ſix inches long, and from one to four inches broad.

Plate IX. Fig. 4. No. 2. (The Briſtly Salmon.) The fat fins and the ſcaly body of this fiſh determine its genus; and as no other ſpecies has ſuch an elongation of the dorſal fin it is ſufficiently characterized by this mark.

The body is ſtraight, the head flat, the aperture of the mouth wide. The inferior *maxilla* projects before the upper one, and they are each of them beſet with very ſmall ſharp teeth. The lips are broad, the noſtrils ſimple, and near the eyes; each of the coverings of the gills are ſcaly, a circumſtance which Dr. Bloch has not diſcovered in any of the other ſpecies. The long tail is compreſſed on the ſides, the ventral fins long, and the lateral lines nearer the belly than the back.

The radii of the fins are pliant; in the pectoral one there are thirteen, in the ventral one nine, in the anal one eleven, in the tail one eighteen, and in the dorſal one which is ſcythe ſhaped, are ſixteen.

The fiſh was ſent to Mr. Pennant from Livorno, and meaſured fourteen inches in length.

Aſiatick

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* B. Tab. xxiv. der fragm.

ASIATICK RESEARCHES, &c. Vol. III.

The Eighth Anniverſary Diſcourſe. By the PRESIDENT.

HAVING in his former diſcourſes given an account of five different Aſiatick nations, derived from Indian, Arabian, and Tartarian ſtocks, the Preſident, in order to complete his hiſtorical reſearches, proceeds to conſider the numerous races of borderers on theſe widely extended regions.

Taking his departure from *Idume* near the gulf of Elanitis, he regards it as indubitable, that a race of men were originally ſettled in Idume, and in Midian, whom the oldeſt Greek writers call *Erythreans*; who were very diſtinct from the Arabs, and who, from many concurring teſtimonies, may be referred to the Indian ſtem. On deſcending the red ſea, we find on the Arabian ſide no traces of any people who were not originally Arabs of the genuine or mixed breed. On turning to the oppoſite coaſt, it may be obſerved that the written Abyſſinian language, which we call Ethiopic, is a dialect of old Chaldean, and a ſiſter of Arabic and Hebrew. It is written, however, like all the Indian characters, from the left hand to the right, and the vowels are annexed to the conſonants. It is the Preſident's opinion, that the Abyſſinians of the Arabian ſtock, having no letters of their own, borrowed thoſe of the black pagans, whom the Greeks call *Troglodytes*, from their dwelling in caves, and who were probably the firſt inhabitants of Africa, and the inventors, or importers, of ſymbolical characters. He believes the Ethiops of Meroe to have been the ſame people with as the firſt Egyptians, and conſequently with the original Hindus.

Proceeding along the Arabian coaſt, the Preſident aſſerts, that whatever may have been ſaid of Scythian colonies formerly ſettled there, he has met with no traces of people in the maritime part of Yemen, who were not either Arabs, or Abyſſinian invaders. And as from the gulf of Perſia, to the rivers Cur and Aras, there are no veſtiges of people diſtinct from the Arabs, Perſians, or Tartars, he concludes there are no ſuch in the Iranian mountains. The principal inhabitants of the mountains which ſeparate Iran from India were anciently diſtinguiſhed among the Brahmans by the name of *Deradas*, but ſeem to have been deſtroyed or expelled by the numerous tribes of Afghans or Patans; and there are ſolid grounds for believing that the *Afghans* are deſcended from the Jews. Their language is evidently a dialect of the ſcriptural Chaldaic.

Coming now to the river *Sindhu* or Indus, and the country named from it, we find near its mouths a diſtrict named by Nearchus, *Sangada*, and ſuppoſed by Mr. D'Anville to be the ſeat of the *Sanganians*, a barbarous and piratical nation. Mr. Malet, reſident at Puna, obtained for the Preſident a ſpecimen of their letters and language, by which the former appear to be a ſort of Nágarì, and the latter, a dialect derived from the Sanſcrit. He does not doubt that the people are what the Brahmans call *Pámeras*, or outcaſt Hindus, immemorially ſeparated from the reſt of the nation. He is inclined to believe, that the *Gypſies*, in whoſe vocabulary are ſo many Sanſcrit words, and whom the Italians call *Zingaros*, or *Zinganos*, were originally *Zinganians*, who in ſome piratical expedition might have landed on the coaſt of Arabia, or Africa, and thence have rambled to Egypt Mr. Malet alſo made the Preſident acquainted with the *Boras*, a race chiefly inhabiting the cities of Gujarât, who, though Muſelmans in religion, are Jews in features, genius and manners.

On the continent of India, between the river *Vipáſa* or Hyphaſis to the weſt, the mountains *Tripura* and *Cámarúpa* to the eaſt, and *Himálaya* to the north, are many races of wild and ferocious people, who probably ſprang from the old Indian ſtem, though ſome of them were ſoon intermixed with Tartarian wanderers.

Coming back to the Indian iſlands, the firſt is *Silán* or *Taprobane*, which was undoubtedly peopled by the Hindu race; nor can it be queſtioned that the ſame tribe planted colonies in the other iſles of the ſame ocean, from the *Malayadwípas*, which take their name from the mountain of Malaya, to the *Moluccas* or *Mallicás*, and probably far beyond them. Captain Forreſt found the iſle of *Bali* chiefly peopled with Hindus; and that of *Madhurà* has the Sanſcrit name of a territory in the weſtern peninſula. The *Jabadios* of Ptolemy, or *Yavadwipa*, which was rendered in the old Latin verſion, the iſle of *Barley*, probably took its name from the word *Yava* which ſignifies *barley* in Sanſcrit, and implies abundance or excellence. D'Anville brings ſtrong reaſons for believing that the ancients did not confine this appellation to the iſland we now call *Java*, but extended it to *Sumatra*, the language of which from Mr. Marſden's account, contains many pure Sanſcrit words. He alſo diſcovered clear veſtiges of one ancient language in all the inſular dialects of the ſouthern ſeas, from *Madagaſcar* to the *Philippines*, and even to the remoteſt iſlands lately viſited.

Turning next to the countries lying between the northern limits of India, and the extenſive domains of the independent Tartars, we firſt meet with the people of *Pótyid* or *Tibet*. That theſe were Hindus, who engrafted the hereſies of Buddha on their old mythological religion, we know from the reſearches of Caſſiano, in Giorgi's compilation. Their characters are apparently Indian, but their language is now written with more letters than are ever pronounced; for though it was anciently Sanſcrit and polyſyllabical, it ſeems at preſent to conſiſt of monoſyllables, to form which in diſcourſe, many letters are ſuppreſſed; and thus we can trace in their writing many Sanſcrit words and phraſes, which in their ſpeaking are undiſtinguiſhable.

As the Tartars were wholly unlettered before their converſion to the religion of Arabia, it may be ſuſpected that the natives of *Eighúr*, *Tancút*, and *Khatà*, who poſſeſſed letters and arts, as well as the *Barmas* or *Brahmachinas*, were not of the Tartarian, but of the Indian family. As to the *Hyperboreans*, from all that can be learned of their ancient religion and manners, they ſeem not to have been of the Tartar, but of the Gothic race, that is, of the Hindu; for the Preſident does not heſitate to aſſume, that the Goths and Hindus had originally the ſame language, gave the ſame appellations to the ſtars and planets, and had the ſame religious rites and opinions. With reſpect to the *Armenian* language, he is convinced that its baſis was ancient Perſian, of the ſame Indian ſtock with the Zend, and that it has been gradually changed ſince Armenia ceaſed to be a province of Iran. The letters in which it now appears are allowed to be comparatively modern. But as to all the races of men who inhabited the branches of Caucaſus, and the northern limits of Iran, the Preſident remarks, that ferocious and hardy tribes who retire for the ſake of liberty, to mountainous regions, and form ſeparate nations, alſo form in the end ſeparate languages, provided that which they carried with them was not fixed by writing, and ſufficiently copious.

Coming back again to the Mediterranean, the principal nations of antiquity who demand attention, are the *Greeks* and *Phrygians*. Theſe had an apparent affinity in religion as well as in language, and it is agreed that they firſt paſſed from Egypt.

The Preſident therefore adds nothing to what he has ſaid of them in his former diſcourſes, except the obſervation, that the grand object of myſterious worſhip in Greece, was the *Mother of the Gods*, or nature perſonified, as ſhe is ſeen among the Indians under a thouſand forms and names. She was called in the Phrygian dialect Má. A drum is called *dindima* both in Sanſcrit and Phrygian, whence, probably, the title of *Dindymene*. *Diana* of Epheſus, and *Aſtarte* of the Syrians and Phœnicians was the ſame under another form; and it cannot be doubted that Syria, Samari, and Phœnice were anciently peopled by a branch of the Indian ſtock, but were afterwards inhabited by an Arabian race.

The Preſident concludes this diſcourſe with juſt touching upon a moſt extraordinary people, that of *Judea*, whoſe language demonſtrates their affinity with the Arabs, but whoſe manners, literature and hiſtory are wonderfully diſtinguiſhed from the reſt of mankind. He aſſerts in general terms the ſuperiority of the Scriptural writings to any other contained in the ſtores of antiquity, and his belief in their inſpiration, reſerving a more particular conſideration of them to a future occaſion.

II. *Obſervations on the Inhabitants of the Garrow Hills, made during a public Deputation in the Years* 1788 *and* 1789. *By* JOHN ELIOT, *Eſq*.

MR. Eliot deputed by government to inveſtigate the duties collected on the *Garrow* hills, which bound the north-eaſtern parts of Bengal, was the firſt European who has travelled among them. The mountaineers of India have generally been conſidered as lawleſs ſavages, whoſe buſineſs is pillage, but it will appear that, as in many ſimilar inſtances, an equitable and kind treatment of them is likely to produce a return of peaceable behaviour on their parts.

On approaching the hills, there is a beautiful proſpect of three ranges of mountains riſing above one another, which vaniſh on coming nearer, leaving only the lower range. The country is rich and verdant, and full of ſmall villages. The head people of the villages are called *Booneahs*. At the paſs of *Ghoſegong*, where Mr. Eliot firſt went, *Oodaſſey Booneah* is looked upon as the head man, but the rightful chief is *Momee*, a woman. The people are thus deſcribed. “A Garrow is a ſtout well ſhaped man, hardy, and able to do much work; of a ſurly look, flat *Cáfri* like noſe, ſmall eyes, generally blue, or brown, forehead wrinkled, and overhanging eye brow, with large mouth, thick lips, and face round and ſhort; their colour is of a light or deep brown; their dreſs conſiſts of a brown girdle, about three inches broad; having in the center a blue ſtripe; it goes round the waiſt, is paſſed between the thighs, and is faſtened behind, leaving one end or flap hanging down before, about eight inches; ſome times it is ornamented with braſs plates; with rows of ivory or a white ſtone ſhaped like bits of tobacco pipes, about half an inch long; the braſs plate is made to reſemble a button, or an apothecary's weight, but more indented: ſome have it ornamented with little bits of braſs, ſhaped like a bell; ſome wear an ornament on their head about three or five inches broad, decorated in the ſame manner as the flap, ſerving to keep their hair off their face, which gives them a wild fierce appearance. Some tie their hair on the crown, in a looſe careleſs manner, while others crop it cloſe. The *Booneahs* or chiefs wear a ſilk turban; to the girdle they affix a bag containing their money and *pawns*, and alſo a net for holding the utenſils with which they light their pipe hung near to it by a chain.

" The women are the ugslieſt creatures I ever beheld, ſhort and ſquat in their ſtatue, with maſculine faces, in the features of which they differ little from the men. Their dreſs conſiſts of a dirty red cloth, ſtriped with blue or white, about ſixteen inches broad, which encircles the waiſt, and covers about three fourths of the thigh. It never reaches to the knee, and being but juſt long enough to tie above on the left ſide, part of the left thigh, when they walk, is expoſed. On their necks they have a ſtring of the ornaments above deſcribed reſembling tobacco pipes, twiſted thirty or forty times round, but negligently, without any attention to regularity; their breaſts are expoſed to view, their only clothing being the girdle above-mentioned; to their ears are affixed numbers of braſs rings, increaſing in diameter from three to ſix inches: I have ſeen thirty of thoſe rings in each ear; a ſlit is made in the lobes of the ear, which increaſe from the weight of the rings, and in time will admit the large number ſtated. This weight is however partly ſupported by a ſtring, which paſſes over their heads; a tape three inches broad ties their hair, ſo as to keep it back from their foreheads, though generally it is tied with a ſtring on the crown of the head. The wives of the *Booneahs* cover their heads with a piece of coarſe cloth, thirteen or fourteen inches broad and two feet long, the end of which, with their hair, hangs down behind, flowing looſe on their backs. The women work as well as the men, and I have ſeen them carry as great burthens. Their hands, even thoſe of the wives of the *Booneahs*, bear evident marks of their laborious occupations.

" Theſe people eat all manner of food, even dogs, frogs, ſnakes, and the blood of all animals. The laſt is baked over a ſlow fire in hollow green bamboos, till it becomes of a naſty dirty green colour. They are fond of drinking to an exceſs. Liquor is put into the mouth of infants, almoſt as ſoon as they are able to ſwallow; they have various ſorts of ſpirits, but that moſtly drunk is extracted from rice, ſoaked in water for three or four days before uſe. Their cookery is ſhort, as they only juſt heat their proviſions; excepting rice and guts, the firſt of which is well boiled, and the other ſtewed till they are black. Indeed excepting theſe, their animal food is eaten almoſt raw.

" In times of ſcarcity many of the hill people ſubſiſt on the *Kebul* which in growth is ſaid to be like the *Palmira*, and the interior part of the *trunk* when pounded, and ſteeped in water, is an article of food, in ſo much as to be the common means of ſuſtenance during a ſcarcity of grain. When boiled it is of a gelatinous ſubſtance, and taſtes when freſh, like a ſugar cane: thoſe, who can afford it, mix rice with it. They alſo ſubſiſt on the *Kutchu*, a ſort of *Yam* found in great plenty, about the hills. I ſaw three ſorts, though I could not learn they had any ſeparate name. One has a number of buds on it, is ſaid to be a cooling medicine, and is eaten boiled or baked. Some of them I brought with me from the hills, and being bruiſed in the baſket uſed in bringing them from the hills, I cut off the rotten part, which I found to be of no detriment to their growth, although out of the ground. At *Dacca* I gave them to Mr. RICHARD JOHNSON, who, I underſtand, delivered them to Colonel KYD, the ſuperintendant of the Company's botanical garden, where, I hear, they have produced a very handſome flower. This plant was cultivated by the *Garrows*, nearly in the ſame manner, as we do potatoes in *England*; a bud being broken off to be ſown for a plant. The *Garrows* ſay it yields, after it is dug out of the ground, and laid by for the enſuing ſeaſon of cultivation (commencing immediately on the breaking up of the rains) from three to ten buds. Another ſort of *Kutchu* grows on the top of the hills, and is found by its ſprout, which twiſts itſelf round the trunk, and branches of the trees. I have ſeen the ſprout from ten to twenty feet high, the leaves have three ſegments like a vine leaf, but more pointed: of deep green, and very ſmall. The root is found from a foot to two feet and a half below the ground, is in ſhape tapering, of a reddiſh colour, and in length from five inches to a foot and a half: it is eaten roaſted. The other ſpecies grows in the ſame manner, but is of a dirty yellow colour.

" The houſes of theſe *Garrows*, called *Chaungs*, are raiſed on piles, about three or four feet from the ground, from thirty to 150 feet in length; and in breadth from ten to forty, and are roofed with thatch. The props of the *Chaung* conſiſt of large *ſaul* timbers: in the center there are eight, and on the ſides from eight to thirty: over theſe are placed horizontally large timbers, for a ſupport to the roof, and tied faſt, ſometimes with ſtrings, but ſtring is rarely uſed for this purpoſe; the tying work being moſtly done with ſlips of graſs or cane. The roof is neatly executed and with as much regularity as any of our Bungalow thatches. When I ſay this, however, I ſpeak of the *Chaungs* of the *Booneahs:* I went into few of the *Chaungs* of the lower claſs. The roof conſiſts of mats and ſtrong graſs. The ſides of the houſe are made from the ſmall hollow bamboos cut open, flatted, and woven as the common mats are. The floor is made in the ſame manner; but of a ſtronger bamboo. The *Chaung* conſiſts of two apartments, one floored and raiſed on piles as deſcribed, and the other without a floor, at one end, for their cattle; at the other end is an open platform, where the women ſit and work. On one ſide is a ſmall raiſed platform, uſually about ſix feet ſquare encloſed at the ſides and open above; here the children play; in the center of the *Chaung* thay cook their victuals, a ſpace of about five feet ſquare being covered with earth; on one ſide a little trap door is made on the floor, for the convenience of the women on certain occaſions, which creates much filth under their *Chaungs*. Indeed a great part of their dirt is thrown under the *Chaung*, and the only ſcavengers I ſaw, were their hogs; but luckily for them, they have plenty of thoſe animals.

" Bugs cover their wearing apparel, of the ſame ſort, as thoſe which infeſt beds in *England:* during my journey along the hills I ſuffered very much from them.

" The diſpoſition of a *Garrow* could not be accurately known in the ſhort time I had to obſerve it; yet my intercourſe with them, which was of the moſt open nature, will, I think, allow me to ſay ſomething of it.

" Their ſurly looks ſeem to indicate ill temper, but this is far from being the caſe, as they are of a mild diſpoſition. They are, moreover, honeſt in their dealings, and ſure to perform what they promiſe. When in liquor they are merry to the higheſt pitch: then men, women and children will dance till they can ſcarce ſtand. Their manner of dancing is as follows: twenty or thirty men of a row ſtanding behind one another, hold each other by the ſides of their belts, and then go round in a circle, hopping on one foot, then on the other, ſinging and keeping time with the muſic, which is animating, though harſh and inharmonious, conſiſting chiefly of tomtoms, and braſs pans, the firſt generally beaten by the old people, and the laſt by the children. The women dance in rows and hop in the ſame manner, but hold their hands out, lowering one hand and raiſing the other at the ſame time, as the muſic beats, and occaſionally turning round with great rapidity. The men alſo exhibit military exerciſes with the ſword and ſhield, which they uſe with grace and great activity. Their dancing at their feſtivals laſts two or three days, during which time they drink and feaſt to an exceſs, inſomuch that it requires a day or two afterwards, to make them perfectly ſober again, yet during this fit of feſtivity and drunkenneſs they never quarrel.

" Marriage is in general ſettled amongſt the parties themſelves, though ſometimes by their parents; if it has been ſettled by the parties themſelves, and the parents of either refuſe their aſſent, the friends of the oppoſite party, and even others unconnected, go and by force compel the diſſenters to comply; it being a rule among the *Garrows* to aſſiſt thoſe that want their help, on theſe occaſions, let the diſparity of age or rank be ever ſo great. If the parents do not accede to the wiſh of their child, they are well beaten till they acquieſce in the marriage."

As to the marriage ceremony, it conſiſts, as in moſt nations, ſavage or civilized, in feaſting and dancing. A cock and hen are ſacrificed by a prieſt, from certain circumſtances attending which, omens are drawn of the event of the marriage. Mr. Eliot was witneſs of the whole ceremonial from being preſent at the marriage of the youngeſt daughter of the chief Oodaſſy, aged ſeven, to the ſon of a common Garrow, aged twenty-three; by virtue of which alliance, the man will ſucceed to the Booneaſhip, as the youngeſt daughter is always heireſs.

The dead are burned, and their aſhes put into a hole where the fire was, covered with a ſmall thatched building, and ſurrounded with a railing. A lamp is kept burning in the building a month or more, and the wearing apparel of the deceaſed is hung upon poles round it. If he be a perſon of rank, a bullock is ſacrificed, and its head burned with the corps. If he be an upper hill Booneah of common rank, the head of one of his ſlaves would be cut off and burned with it; if one of the firſt rank, his ſlaves ſally out and ſeize a Hindu, whoſe head they cut off and burn with their chief.

Their religion approaches that of the Hindus in the worſhip of MAHADE'VA. At *Baunjaun*, a paſs in the hills, they worſhip the ſun and the moon; all their religious ceremonies being preceded by a ſacrifice of a bull, goat, hog, cock, or dog. The animal is put to death by cutting off its head.

" Their mode of ſwearing at *Ghoſegong* is very ſolemn: the oath is taken upon a ſtone, which they firſt ſalute, then with their hands joined and uplifted, their eyes ſteadfaſtly fixed to the hills, they call on MAHADE'VA in the moſt ſolemn manner, telling him to witneſs what they declare, and that he knows, whether they ſpeak true or falſe. They then again touch the ſtone with all the appearance of the utmoſt fear, and bow their heads to it, calling again upon MAHADE'VA. They alſo during their relation, look ſteadfaſtly to the hills and keep their right hand on the ſtone. When the firſt perſon ſwore before me, the awe and reverence, with which the man ſwore, forcibly ſtruck me: my *Moherrir* could hardly write, ſo much was he affected by the ſolemnity. In ſome of the hills they put a tiger's bone between their teeth, before they relate the ſubject to be depoſed: others take earth in their hand; and, on ſome occaſions, they ſwear with their weapons in their hands. I underſtand their general belief to be, that their God reſides in the hills; and, though this belief may ſeem inconſiſtent with an awful idea of the divinity, theſe people appeared to ſtand in the utmoſt awe of their deity, from their fear of his puniſhing them for any miſconduct in their frequent excurſions to the hills."

Their puniſhments conſiſt moſtly in fines, the produce of which is appropriated to feaſting and drinking. Adultery, murder, and robbery are puniſhed with inſtant death. In their deliberations they aſſemble in their war dreſs, and ſitting in a circle, their chiefs diſcuſs the matter, their wives exerting as much authority as themſelves. Their mode of ſettling payments is by ſticks; each of the inferior Garrows places as many ſticks in a pan as he can give of the article required, and the Booneahs make up the deficiencies. They keep their accounts alſo by ſticks.

In caſe of illneſs they make a ſacrifice to the deity, and make uſe of medicines, the greater part of which are charms and amulets. Inoculation is common among them, but appears to have been introduced only of late years. They have a yearly inoculator, whom they liberally reward, and treat with great reſpect. Among the Garrows, a kind of madneſs exiſts, which they call transformation into a tiger, the perſon affected, ſhunning ſociety, and roaming about like that animal. It is probably a ſpecies of melancholy occaſioned by frequent intoxication.

" At the foot of the hills reſide a caſt of people called *Hajins*; their cuſtoms nearly reſemble the *Garrows*; in religious matters they partake more of the *Hindus*, as they will not kill a cow: their habitations are built like the houſes of the ryotts in general, but are better made, encloſed with a court yard, kept remarkably neat and clean, the railing made of bamboos ſplit, flatted, and joined together; the ſtreets of their villages, equal the neatneſs of their houſes. The men are of a dark complexion, well made and ſtout; their face nearly reſembles the *Garrow*, though rather of a milder look; their dreſs is the ſame as that of the head peaſants in *Bengal*, conſiſting of a *Dootee*, *Egpautah* and *Pugree*, or waiſt-cloth, mantle, and turband.

" The women are remarkably neat and clean: their dreſs conſiſts of one cloth, made to go near twice round the body and to hang in folds, down to the ancle, covers their breaſts, and paſſes under their arms, and the ends are tucked in as the waiſt-cloth of the natives of *Bengal*: their hair is tied on the crown, and they have ear rings in the ſame manner as the *Garrow* women, but no neck ornament."

III. *A Royal Grant of Land in Carnata, tranſlated from the Sanſcrit.* *By the* PRESIDENT.

AFTER a long genealogical introduction full of mythology in the high poetical eaſtern ſtyle, follows the ſpecification of a tract of land granted by the king *Criſhnaráya* for religious purpoſes.

IV. *On the Muſical Modes of the Hindus.*

Reſerved.

V. *An Account of the Battle of Paniput, and of the Events leading to it. Written in Perſian, by* Ca'si Raja Pundit, *who was preſent at the Battle.*

S*Edaſheo Row Bhow*, commonly called *the Bhow*, being at the head of affairs in the Decan, formed a plan of putting a period to the Muſſulman dominion in Hindoſtan. The execution of this project was firſt committed to *Raghunaut Row*, who marching a numerous army into Hindoſtan, took poſſeſſion of part of the country, but was compelled, for want of money, to return. The next year the ſcheme being renewed, the *Bhow* himſelf took the command, accompanied by *Biſwas Row*, a youth of ſeventeen, eldeſt ſon of *Bala Row*, as nominal commander; and aſſembling the whole *Mahratta* forces under their ſeveral chiefs, advanced into the enemy's country, where he ſeized upon Dehli, and plundered great part of the royal effects there. On the other ſide, *Ahmed Shah Durrany*, collecting an army of Durranies, Rohillas, and Hindoſtany Muſſulmans, oppoſed his further progreſs. *Shuja ul Dowlah*, vizier of Hindoſtan, wavered ſome time between the contending powers, but at length joined the reſt of the Muſſulmans. Towards the end of October, 1760, the two armies came in ſight of each other near Paniput, where the *Bhow* fixed his camp, the *Shah* encamping at a ſmall diſtance from him. They continued in this ſituation for near three months, during which there were three ſevere but partial actions. The Mahratta army beginning to ſuffer under a ſcarcity of proviſions and forage, ſome overtures were made by the *Bhow*, through the channel of the writer of this account, to induce *Shujah ul Dowlah* to mediate a peace for him; but the deſtruction of the Mahrattas being reſolved upon, they were not liſtened to. At length, in the morning of January the 7th, the Mahrattas, being no longer able to endure their diſtreſſes, marched out with determined reſolution to the attack. *Ahmed Shah* received them with equal courage; and a moſt bloody action enſued, with various ſucceſs, till afternoon, when the *Bhow* falling, the whole Mahratta army turned their backs, and fled full ſpeed. The carnage in the purſuit was dreadful. The number of perſons of all deſcriptions in the Mahratta camp was eſtimated at 500,000, of whom the greateſt part were killed or taken priſoners; and the booty was immenſe. *Biſwas Row* was found dead in the field; and after a ſtrict ſearch, a headleſs body was diſcovered, which by the marks appeared to be that of the *Bhow*, and the head was afterwards brought in. Yet in the year 1779 a man appeared, who pretended to be the *Bhow*, and for a time obtained credit.

This deciſive action terminated the deſigns of the Mahrattas, who were reduced ſo low by it, as ſcarcely yet to have recovered their former conſequence. The conquerors were near falling out among themſelves, chiefly from the inſolence and barbarity of the Durranies, who at length were led back to Kabul by the *Shah*. Such is the general ſubſtance of this narration, which, however, contains many minute and curious particulars, characteriſtic of the civil and military conduct of thoſe people, but which are incapable of abridgment. The tranſlation is ſaid by its author to be far from literal, his purpoſe having been to make it as plain and unadorned as poſſible.

The remainder of the *Aſiatic Reſearches* will be given in our next Part.

Tranſactions of the American Philoſophical Society, held at Philadelphia, for promoting uſeful Knowledge. Vol. III. 1793.

THIS volume commences with an Introduction, which is an Eſſay on thoſe inquiries in Natural Philoſophy which are at preſent moſt beneficial to the United States of North America, by Dr. Nicholas Collin, Rector of the Swediſh Churches in Pennſylvania. The firſt article touched upon is *Medical Inquiries.* Five diſeaſes are here mentioned, as in a peculiar manner affecting North America, and therefore deſerving attention—Nervous diſorders, rheumatiſm, intermitting fevers, loſs of teeth, and colds. Some circumſtances of air, diet, clothing, and cuſtoms, which may contribute to them, are ſlightly noticed. The next article is *Inquiries relative to Rural Economy.* Modes and particular objects of cultivation, and of rural management, are here ſuggeſted, with other things belonging to the preſent circumſtances of the States. *Phyſico-Mathematical Inquiries* are the next article, under which are arranged mechanical inventions, architecture, ſurveying, &c. The 4th article is *Inquiries in Natural Hiſtory,* which opens a wide field comprehending the different kingdoms of nature. Of the vegetable creation the ſubjects are conſidered as affording medicine, food, dyes, and ornament. Among animals, inſects are firſt enumerated, with ſome facts reſpecting them; and then the other claſſes. *Meteorological Inquiries* compoſe the laſt article, in which are mentioned the ſtorms, irregularity of ſeaſons, and ſudden changes in the American climates.

I. *Conjectures concerning the Formation of the Earth, &c. in a Letter from Dr.* FRANKLIN *to the Abbé* SOULAVIE.

THE firſt idea contained in this letter (which is dated from Paſſy, September 1782) is, that the internal part of this globe may be a fluid, denſer and heavier than any of the ſolids with which we are acquainted. The ſurface of the globe may therefore be a ſhell, capable of being broken and diſordered by any violent movements of the fluid on which it reſts. The denſe fluid occupying the internal parts may be compreſſed air; and its expanſive force, which will be in proportion to its denſity, may be an agent in moving the ſurface, as well as in keeping alive ſubterraneous fires. He proceeds,

If one might indulge imagination in ſuppoſing how ſuch a globe was formed, I ſhould conceive, that all the elements in ſeparate particles being originally mixed in confuſion and occupying a great ſpace, they would, as ſoon as the almighty fiat ordained gravity or the mutual attraction of certain parts, and the mutual repulſion of other parts, to exiſt, all move towards their common centre: that the air being a fluid whoſe parts repel each other, though drawn to the common centre by their gravity, would be denſeſt towards the centre, and rarer as more remote; conſequently all matters lighter than the central part of that air, and immerſed in it, would recede from the centre, and riſe till they arrived at that region of the air which was of the ſame ſpecific gravity with themſelves, where they would reſt; while other matter, mixed with the lighter air, would deſcend, and the two meeting would form the ſhell of the firſt earth, leaving the upper atmoſphere nearly clear. The original movement of the parts towards their common centre would naturally form a whirl there, which would continue in the turning of the new-formed globe upon its axis; and the greateſt diameter of the ſhell would be in its equator. If by any accident afterwards the axis ſhould be changed, the denſe internal fluid by altering its form muſt burſt the ſhell, and throw all its ſubſtance into the confuſion in which we find it.

Dr. Franklin then takes occaſion, from the Abbé's obſervation of the ferruginous nature of the lava thrown out of volcanos, to mention his ſuppoſition, that the iron contained in this globe has made it capable of becoming a great magnet—that the fluid of magnetiſm exiſts in all ſpace, ſo that there is a magnetical north and ſouth of the univerſe, as well as of our earth; and that it was by the power of this general magnetiſm that this globe became a particular magnet. In ſoft or hot iron the magnetic fluid is naturally diffuſed equally. When, within the influence of a magnet, it is drawn to one end of the iron, and made denſer there, and rarer at the other, while the iron continues ſoft or hot, it is only a temporary magnet; but if it cools or hardens in this ſituation, it becomes a permanent one. Perhaps it may be owing to the permanent magnetiſm of this globe, which it had not at firſt, that its axis is at preſent kept parallel to itſelf, and not liable to the changes it formerly ſuffered, which occaſioned the rupture of its ſhell, the ſubmerſions and emerſions of its lands, and the confuſion of its ſeaſons. The preſent polar and equatorial diameters differing from each other near ten leagues; it is eaſy to conceive, in caſe ſome power ſhould ſhift the axis gradually, and place it in the preſent equator, and make the new equator paſs through the preſent poles, what a ſinking of the water would happen in the preſent equatorial regions, and what a riſing in the preſent polar regions; ſo that vaſt tracts would be diſcovered that now are under water, and others covered that now are dry, the water riſing and ſinking in the different extremes near five leagues. Such an operation as this, poſſibly, occaſioned much of Europe, and among the reſt, this mountain of Paſſy, on which I live, and which is compoſed of lime-ſtone, rock and ſea ſhells, to be abandoned by the ſea, and to change its ancient climate, which ſeems to have been a hot one. The globe being now become a permanent magnet, we are perhaps ſafe from any future change of its axis. But we are ſtill ſubject to the accidents on the ſurface which are occaſioned by a wave in the internal ponderous fluid; and ſuch a wave is producible by the ſudden violent exploſion you mention, happening from the junction of water and fire under the earth, which not only lifts the incumbent earth that is over the exploſion, but, impreſſing with the ſame force the fluid under it, creates a wave that may run a thouſand leagues, lifting and thereby ſhaking ſucceſſively all the countries under which it paſſes.

II. *A new and curious Theory of Light and Heat*; *in a Letter from Dr.* B. FRANKLIN *to* DAVID RITTENHOUSE, *Eſq.*

UNIVERSAL ſpace, as far as we know of it, ſeems to be filled with a ſubtile fluid, whoſe motion, or vibration, is called light.

This fluid may poſſibly be the ſame with that, which, being attracted by and entering into other more ſolid matter, dilates the ſubſtance, by ſeparating the conſtituent particles, and ſo rendering ſome ſolids fluid, and maintaining the fluidity of others; of which fluid when our bodies are totally deprived, they are ſaid to be frozen; when they have a proper quantity, they are in health, and fit to perform all their functions; it is then called natural heat; when too much, it is called fever; and when forced into the body in too great a quantity from without, it gives pain by ſeparating and deſtroying the fleſh, and is then called burning; and the fluid ſo entering and acting is called fire.

While organized bodies, animal or vegetable, are augmenting in growth, or are ſupplying their continual waſte, is not this done by attracting and conſolidating this fluid, called fire, ſo as to form of it a part of their ſubſtance; and is it not a ſeparation of the parts of ſuch ſubſtance, which, diſſolving its ſolid ſtate, ſets that ſubtile fluid at liberty, when it again makes its appearance as fire?

For the power of man, relative to matter, ſeems limited to the ſeparating or mixing the various kinds of it, or changing its form and appearance by different compoſitions of it; but does not extend to the making or creating of new matter, or annihilating the old: thus, if fire be an original element or kind of matter, its quantity is fixed and permanent in the univerſe. We cannot deſtroy any part of it, or make addition to it. We can only ſeparate it from that which confines it, and ſo ſet it at liberty, as when we put wood in a ſituation to be burnt; or transfer it from one ſolid to another, as when we make lime by burning ſtone, a part of the fire diſlodged from the fuel being left in the ſtone. May not this fluid, when at liberty, be capable of penetrating and entering into all bodies, organized or not; quitting eaſily in totality thoſe not organized, and quitting eaſily in part thoſe which are; the part aſſumed and fixed remaining till the body is diſſolved?

Is it not this fluid which keeps aſunder the particles of air, permitting them to approach, or ſeparating them more, in proportion as its quantity is diminiſhed or augmented?

Is it not the greater gravity of the particles of air, which forces the particles of this fluid to mount with the matters to which it is attached, as ſmoke or vapour?

Does it not ſeem to have a great affinity with water, ſince it will quit a ſolid to unite with that fluid, and go off with it in vapour; leaving the ſolid cold to the touch, and the degree meaſurable by the thermometer?

The vapour riſes attached to this fluid; but at a certain height they ſeparate, and the vapour deſcends in rain, retaining but little of it, in ſnow or hail leſs. What becomes of that fluid? Does it riſe above our atmoſphere, and mix with the univerſal maſs of the ſame kind?

Or does a ſpherical ſhell or ſtratum of it, denſer, as leſs mixed with air, attracted by this globe, and repelled or puſhed up only to a certain height from its ſurface, by the greater weight of air, remain there ſurrounding the globe, and proceeding with it round the ſun?

In ſuch caſe, as there may be a continuity or communication of this fluid through the air quite down to the earth, is it not by the vibrations given to it by the ſun, that light appears to us; and may it not be, that every one of the infinitely ſmall vibrations, ſtriking common matter with a certain force, enters its ſubſtance, is held there by attraction, and augmented by ſucceeding vibrations, till the matter has received as much as their force can drive into it?

Is it not thus that the ſurface of this globe is continually heated by ſuch repeated vibrations in the day, and cooled by the eſcape of the heat when thoſe vibrations are diſcontinued in the night, or intercepted and reflected by clouds?

Is it not thus that fire is amaſſed, and makes the greateſt part of the ſubſtance of combuſtible bodies?

Perhaps when this globe was firſt formed, and its original particles took their place at certain diſtances from the centre, in proportion to their greater or leſs gravity, the fluid fire, attracted towards that centre, might in great part be obliged, as lighteſt, to take place above the reſt, and thus form the ſphere of fire above ſuppoſed; which would afterwards be continually diminiſhing by the ſubſtance it afforded to organized bodies, and the quantity reſtored to it again by the burning or other ſeparating of the parts of thoſe bodies?

Is not the natural heat of animals thus produced by ſeparating in digeſtion the parts of food, and ſetting their fire at liberty?

Is it not this ſphere of fire which kindles the wandering globes that ſometimes paſs through it in our courſe round the ſun, have their ſurface kindled by it, and burſt when their included air is greatly rarefied by the heat on their burning ſurface?

May it not have been from ſuch conſiderations that the ancient philoſophers ſuppoſed a ſphere of fire to exiſt above the air of our atmoſphere?

III. *Deſcription of the Proceſs to be obſerved in making large Sheets of Paper in the Chineſe Manner, with one ſmooth Surface. Communicated by Dr.* B. FRANKLIN.

IN Europe, to have a large ſurface of paper connected together and ſmooth on one ſide, the following operations are performed.

1. A number of ſmall ſheets are to be made ſeparately.

2. Theſe are to be couched, one by one, between blankets.

3. When a heap is formed, it muſt be put under a ſtrong preſs, to force out the water.

4. Then the blankets are to be taken away, one by one, and the ſheets hung up to dry.

5. When dry, they are to be again preſſed, or if to be ſized, they muſt be dipped into ſize made of warm water, in which glue and alum are diſſolved.

6. They muſt then be preſſed again, to force out the ſuperfluous ſize.
7. They muſt then be hung up a ſecond time to dry, which, if the air happens to be damp, requires ſome days.
8. They muſt then be taken down, laid together, and again preſſed.
9. They muſt be paſted together at their edges.
10. The whole muſt be glazed by labour, with a flint.

In China, if they would make ſheets, ſuppoſe of four and an half ells long, and one and an half ell wide, they have two large vats, each five ells long and two ells wide, made of brick, lined with a plaſter that holds water. In theſe the ſtuff is mixed ready to work.

Between theſe vats is built a kiln or ſtove, with two inclining ſides; each ſide ſomething larger than the ſheet of paper; they are covered with a fine ſtucco that takes a poliſh, and are ſo contrived as to be well heated by a ſmall fire circulating in the walls.

The mould is made with thin but deep ſides, that it may be both light and ſtiff: it is ſuſpended at each end with cords that paſs over pullies faſtened to the ceiling, their ends connected with a counterpoiſe nearly equal the weight of the mould.

Two men, one at each end of the mould, lifting it out of the water by the help of the counterpoiſe, turn it and apply it, with the ſtuff for the ſheet, to the ſmooth ſurface of the ſtove, againſt which they preſs it, to force out great part of the water through the wires. The heat of the wall ſoon evaporates the reſt, and a boy takes off the dried ſheet by rolling it up. The ſide next the ſtove receives the even poliſh of the ſtucco, and is thereby better fitted to receive the impreſſion of fine prints. If a degree of ſizing is required, a decoction of rice is mixed with the ſtuff in the vat.

Thus the great ſheet is obtained, ſmooth and ſized, and a number of the European operations ſaved.

As the ſtove has two poliſhed ſides, and there are two vats, the ſame operation is at the ſame time performed by two other men at the other vat; and one fire ſerves.

IV. *Queries and Conjectures relating to Magnetiſm, and the Theory of the Earth, in a Letter from* Dr. B. FRANKLIN *to* Mr. BODOIN.

HAS the queſtion, how came the earth by its magnetiſm, ever been conſidered? Is it likely that *iron ore* immediately exiſted when this globe was firſt formed; or may it not rather be ſuppoſed a gradual production of time?

If the earth is at preſent magnetical, in virtue of the maſſes of iron ore contained in it, might not ſome ages paſs before it had magnetic polarity?

Since iron ore may exiſt without that polarity, and, by being placed in certain circumſtances, may obtain it from an external cauſe, is it not poſſible that the earth received its magnetiſm from ſome ſuch cauſe?

In ſhort, may not a magnetic power exiſt throughout our ſyſtem, perhaps through all ſyſtems, ſo that if men could make a voyage in the ſtarry regions, a compaſs might be of uſe? And may not ſuch univerſal magnetiſm, with its uniform direction, be ſerviceable in keeping the diurnal revolution of a planet more ſteady to the ſame axis?

Laſtly, as the poles of magnets may be changed by the preſence of ſtronger magnets, might not, in ancient times, the near paſſing of ſome large comet of greater magnetic power than this globe of ours have been a means of changing its poles, and thereby wracking and deranging its ſurface, placing in different regions the effect of centrifugal force, ſo as to raiſe the waters of the ſea in ſome, while they were depreſſed in others?

Let me add another queſtion or two, not relating indeed to magnetiſm, but, however, to the theory of the earth.

Is not the finding of great quantities of ſhells and bones of animals (natural to hot climates) in the cold ones of our preſent world, ſome proof that its poles have been changed? Is not the ſuppoſition, that the poles have been changed, the eaſieſt way of accounting for the deluge, by getting rid of the old difficulty how to diſpoſe of its waters after it was over? Since if the poles were again to be changed, and placed in the preſent equator, the ſea would fall there about 15 miles in height, and riſe as much in the preſent polar regions; and the effect would be proportionable, if the new poles were placed any where between the preſent and the equator.

Does not the apparent wrack of the ſurface of this globe, thrown up into long ridges of mountains, with ſtrata in various poſitions, make it probable, that its internal maſs is a fluid; but a fluid ſo denſe as to float the heavieſt of our ſubſtances? Do we know the limit of condenſation air is capable of? Suppoſing it to grow denſer *within* the ſurface, in the ſame proportion nearly as we find it does *without*, at what depth may it be equal in denſity with gold?

Can we eaſily conceive how the ſtrata of the earth could have been ſo deranged, if it had not been a mere ſhell ſupported by a heavier fluid? Would not ſuch a ſuppoſed internal fluid globe be immediately ſenſible of a change in the ſituation of the earth's axis, alter its form, and thereby burſt the ſhell, and throw up parts of it above the reſt? As if we would alter the poſition of the fluid contained in the ſhell of an egg, and place its longeſt diameter where the ſhorteſt now is, the ſhell muſt break; but would be much harder to break if the whole internal ſubſtance were as ſolid and hard as the ſhell.

Might not a wave, by any means raiſed in this ſuppoſed internal ocean of extremely denſe fluid, raiſe in ſome degree, as it paſſes, the preſent ſhell of incumbent earth, and break it in ſome places, as in earthquakes? And may not the progreſs of ſuch wave, and the diſorders it occaſions among the ſolids of the ſhell, account for the rumbling ſound being firſt heard at a diſtance, augmenting as it approaches, and gradually dying away as it proceeds? A circumſtance obſerved by the inhabitants of South-America in their laſt great earthquake, that noiſe coming from a place ſome degrees north of Lima, and being traced by enquiry quite down to Buenos Ayres, proceeding regularly from North to South at the rate of — leagues per minute, as I was informed by a very ingenious Peruvian whom I met with at Paris.

V. *Explanation of a ſingular Phenomenon, firſt obſerved by Dr.* FRANKLIN. *By Mr.* R. PATTERSON.

IN one of Dr. Franklin's philoſophical tracts is an account of a ſingular phenomenon, obſerved when a veſſel containing oil and water is put in motion—Thus if a glaſs tumbler, for inſtance, about two thirds filled, with equal parts of water and oil, be moved gently backwards and forwards in the hand; or, ſuſpended by a cord, be made to ſwing like the pendulum of a clock, the ſurface of the water in contact with the oil, which floats upon it, will be thrown into a violent wave-like commotion, while the upper ſurface of the oil will be comparatively placid and even.

Various explanations of this have been offered, but none that ſeem ſatisfactory. Mr. P. offers the following:

1. When the tendency of a body *upwards* is *juſt* equal to its tendency *downwards*, it will then, upon the *leaſt* impulſive force, move indifferently in either direction.

This is the caſe of a body immerſed in a fluid of the ſame ſpecific gravity; where the buoyancy of the fluid, to raiſe the body upwards, is juſt equal to the power of gravity, to draw it downwards.

2. When the tendency of a body *upwards* is *nearly* equal to its tendency *downwards*, then, a *ſmall* impulſive force upwards, will move it in that direction.

This is the caſe of a body immerſed in a fluid of *nearly* equal ſpecific gravity; for then the relative gravity, or tendency of the body downwards, will be only the exceſs of its ſpecific gravity above that of the fluid in which it is immerſed. But water immerſed in common oil is juſt in the circumſtances laſt mentioned; and therefore a ſmall impulſive force, ſuch as that communicated by ſwinging the veſſel backwards and forwards, will be ſufficient to raiſe the water into waves, and produce that commotion which is deſcribed by Dr. Franklin in the experiment alluded to.

If this reaſoning be juſt, then, the leſs difference there is between the ſpecific gravities of the two fluids, the greater will the agitation excited in the lower fluid be, and *vice verſa*; and accordingly you will conſtantly find this to be the caſe. For if quickſilver be one of the fluids, the waves excited in it will be but very ſmall; if water and oil be uſed, the waves on the water will be much greater; but if ſpirits and oil, of nearly equal ſpecific gravities, be made uſe of, the commotion excited in the lower fluid will be very conſiderable indeed.

Hence we ſee the reaſon why the motion given to a mug of cider or beer, after having ſtood before the fire to warm, by ſwinging it backwards and forwards in the hand, as the common cuſtom is in the winter, before one drinks, will ſo effectually mix the cold and warm parts of the liquor together, which before occupied different places in the mug.

The placid appearance of the upper ſurface of the oil, in the above experiment, is no doubt to be attributed, *in part*, to the tenacity, or glutinous conſiſtence of that fluid; but the chief cauſe undoubtedly is the great difference between its ſpecific gravity and that of the air—the fluid in which it is immerſed. For if oil be made the lower fluid, by uſing with it any other fluid of leſs ſpecific gravity, it will, notwithſtanding the tenacity of its particles, while any conſiderable degree of fluidity remains, be affected in the ſame manner as any other fluid in like circumſtances.

VI. *A*

VI. *An Account of an Earthy Subſtance found near the Falls of Niagara, and vulgarly called The Spray of the Falls; together with ſome Remarks on the Falls.* *By* ROBERT M'CAUSLIN, *M. D.*

THIS ſubſtance is found in great plenty every where about the bottom of the Falls, ſometimes lying looſe among the ſtones on the beach, and ſometimes adhering to the rocks, or appearing between the layers on breaking them. The maſſes are of various ſizes and ſhapes, but ſeldom exceed the bulk of a man's hand. Sometimes they are ſoft and crumbling like damp ſugar; whilſt other pieces are quite hard, and of a ſhining foliated appearance, or elſe opake, and reſembling burnt alum. Both theſe forms are often found in the ſame maſs. Pieces which are taken up ſoft, ſoon become hard by keeping, and never long continue in a ſoft ſtate. In order to diſcover the nature of this ſubſtance, it was ſubmitted to various experiments.

An opake piece, put into dilute vitriolic acid, underwent no efferveſcence or diminution. The ſame was the reſult with a ſhining piece. Vinegar had no action upon it. A piece was calcined fifteen hours in a blackſmith's forge. It produced no ebullition with water, yet gave it a weak impregnation of lime. Alkali added to it cauſed a precipitation. Hot water, poured upon this ſubſtance reduced to powder, was found, upon ſettling, to have acquired no taſte of lime-water, yet took up ſome earthy particles, as was proved by the precipitation enſuing on adding fixed alkali. The concluſions drawn from theſe few experiments are, that this concrete is not an alkaline earth, but a combination of an acid with calcareous earth, and properly to be ranked among the ſelenites.

It is the opinion of the country, that the water is purified on coming down the Falls. This idea was at firſt adopted by the writer, who conceived that the violent agitation it underwent in paſſing over the rapids, and tumbling down the Fall, might cauſe a depoſition of its earth. But ſucceeding obſervations led him to doubt of the fact. The water is certainly better at Niagara, thirteen or fourteen miles below the Falls, than at Fort Schloſſer, one mile and a half above them; but this may be attributed to other cauſes; and at Fort Erie, twenty miles above the Falls, the water is eſteemed as good as at Niagara. Further, on weighing with great exactneſs the water at Niagara and Fort Schloſſer, the ſpecific gravity was found to be preciſely the ſame.

In inquiring into the formation of this ſubſtance, it is obſerved, 1. That the rocks near the Falls are kept conſtantly wet by a thick miſt of vapour; 2. That theſe rocks are very apt to crack and ſplit; 3. That upon ſeparating the layers of theſe rocks, there is generally ſpray found between them in a ſoft ſtate. The ſubſtance is never found above the Falls, nor much more than a mile below them. Cloſe to the Falls, it is found between the layers of moſt of the rocks; the quantity diminiſhing in proportion to the diſtance. From theſe circumſtances, he thinks it probable that it is formed by a ſlow filtration of the moiſture through the layers of the rocks; the previous agitation having perhaps diſpoſed the water more eaſily to part with its earth than before. That part of the vapour, which hangs upon the ſurrounding rocks, may be the heavieſt, as moſt loaded with earthy particles, while the lighter mounts into the air. The pieces of ſpray, found among the ſtones of the beach, have been brought there in conſequence of the ſplitting and fall of the rocks where it is formed.

The accounts given of the height of the Fall vary conſiderably, one reaſon of which is, that the fall is higher on one ſide than on the other. By the moſt accurate calculation that could be made by the writer, the ſouth-weſt ſide is one hundred and forty-three feet, and the north-eaſt one hundred and ſixty-three feet. The declivity of the rapids immediately above the Fall may probably amount to half the height of the Falls themſelves. Six or ſeven miles below the Falls, the country deſcends by a conſiderable and ſudden declivity, forming a ridge, which divides the high land in the vicinity of the Falls from the low land on which Fort Niagara ſtands. It is the univerſal belief, that the cataract was originally at this ridge, and that it has by degrees worn away and broke the rock for the ſpace of theſe ſix or ſeven miles. The preſent retroceſſion of the Falls, however, does not go on at any rate which would bring this change within any thing near the ſuppoſed period from the creation of our world. From the obſervation of nine years, the writer has perceived very few pieces of rock fallen down large enough to make any ſenſible alteration in the brink.

VII. *Obſervations on the Probabilities of the Duration of Human Life, and the Progreſs of Population in the United States of America. By* WILLIAM BARTON, *Eſq.*

THE general cauſes of the rapid progreſs of population in the American States are here ſaid to be, the ſalubrity of the climate; the great fruitfulneſs and reſources of the country; the conſequent facility of acquiring means of ſubſiſtence, which favours early marriages; and the virtuous and ſimple manners of the great body of inhabitants.

In order to ſhew the difference between the progreſs of population in the new world and in the old, the writer proceeds to the conſideration of ſuch data as authentic documents afford. The firſt point he endeavours to eſtabliſh, is the greater proportion of births to marriages in America. After adducing various European calculations, to ſhew that $4\frac{1}{2}$ perſons to a houſe, and the ſame proportion of births to a marriage, is an allowance large enough for ſome of the healthieſt parts of Europe, he gives the following American eſtimates. In the firſt pariſh of Hingham, in Maſſachuſetts, for a period of 54 years, $6\frac{1}{4}$ births to one marriage. From the laſt cenſus of the State of Maſſachuſetts, upwards of $5\frac{2}{3}$ (excluſive of Indians and Negroes) to a *family*, and $6\frac{35}{100}$ to a *houſe*. Another mode of aſcertaining this point is the proportion of annual births to the exiſting inhabitants. After diſcuſſing various eſtimates made in France and England, he gives the following reſults:

In France,	1 birth	to	26 inhabitants.
England,	1 ditto	to	$26\frac{1}{2}$ ditto.
Paris,	1 ditto	to	30 ditto.
London,	1 ditto	to	$32\frac{1}{2}$ ditto.
Philadelphia,	1 ditto	to	$22\frac{1}{2}$ ditto.

The proportion of perſons under 16 years, to thoſe above that age, is another circumſtance from which increaſing population may be inferred. Dr. Halley has computed thoſe under 16 to be only one third of the whole; but from the cenſus of New-Jerſey at two periods it has been found as $47\frac{63}{100}$ to 100; and as $49\frac{55}{100}$ to 100: from the cenſus of Maſſachuſetts, as $48\frac{2}{100}$ to 100; from that of Philadelphia, as $41\frac{88}{100}$ to 100.

The exceſs of births above deaths is another circumſtance denoting increaſing population. This has been found to turn out very differently in European calculations, according as the ſubject was a large or a ſmall town, or a whole country. We ſhall not repeat this writer's ſtatements from Dr. Price, and other writers, but ſhall only give his own, for America.

	Births.	Deaths.
Salem, in Maſſachuſetts, for 1782, 1783,	to 100	49
Hingham, in Maſſachuſetts, for 54 years,	to 100	49,5
Philadelphia, city and ſuburbs,	to 100	50

The comparative longevity is the next conſideration. This is peculiarly difficult to eſtimate in a country under the circumſtances of America, ſubject to continual fluctuations of migration, and rapidly increaſing in population. The few eſtimates given from proper documents are as follows:

	Out of 1000 deaths.	
Ipſwich hamlet, Maſſachuſetts, for 10 years	128	above 80 years.
Hingham, Maſſachuſetts, 54 years -	90·91	
Connecticut, the whole State - -	74	
Milford, Connecticut, 12 years -	74	
Salem, Maſſachuſetts, 2 years - -	26	
Philadelphia, 4 years - - -	25	

The proportion which the annual deaths bear to the number of the living is another datum with reſpect to the progreſs of population. This is well known to be very different in different ſituations, large towns giving a much greater proportion than ſmall ones, and theſe than the country. The American aſcertained ſtatements are theſe:

Salem, in Maſſachuſetts - -	1 to 47
Philadelphia, city and ſuburbs - -	1 to 45
Savanna, in Georgia - - -	1 to 31·7

That for all France has been fixed at 1 to 35, and for all England, at 1 to 33.

The known increaſe of population in America, ſince the ſettlement of its different parts by Europeans, is another obvious proof of rapid progreſſion in this reſpect. The increaſe in Virginia, ſince 1654, when importations in great meaſure ceaſed, and the people were become too numerous to be ſenſibly affected by Indian wars, amounts to a duplication once in every 27 $\frac{1}{4}$ years. New-England has doubled its number every 25 years. Dr. Franklin was of opinion, that the people of the States doubled every 20 years. Dr. Price ſuppoſes that in the back ſettlements they double every 15 years; and all through the northern colonies, every 25 years.

The writer next examines the longevity of the inhabitants of North America; and adduces a number of inſtances (which will not admit of abridgment) of great length of years attained by perſons in the various ſtates, not excluding the ſouthern. A conſiderable number of theſe exceeded 100 years. From all the obſervations in this paper, he concludes, that the probability of life *in all its ſtages* is higher in the United States,

than

than in the healthieſt European countries; and hence argues, that the people muſt in general enjoy healthy conſtitutions, and that the climate muſt be favourable to human life. Further to illuſtrate the ſubject, he has added tables ſhewing the probabilities of the duration of life at the city of Philadelphia, and the town of Salem, contraſted with others from Buffon, Dr. Price, and other European writers. Other tables are ſubjoined, from which we have already extracted the articles relative to America.

VIII. *Extract of a Letter from* ANDREW ELLICOTT *to* DAVID RITTENHOUSE, *Eſq. dated at Pittſburg, November 5th* 1787, *containing Obſervations made at Lake-Erie.*

ON the thirteenth of laſt month, while we lay on the banks of Lake-Erie, we had an opportunity of viewing that ſingular phenomenon, by ſeamen termed looming. It was preceded by a fine Aurora-borealis, on the evening of the 12th—the 13th was cloudy, but without rain: about ten o'clock in the morning, as I was walking on the beach, I diſcovered ſomething that had the appearance of land, in the direction of Preſque-Iſle; about noon it became more conſpicuous; and when viewed by a good achromatic teleſcope, the branches of the trees could be plainly diſcovered. From three o'clock in the afternoon, till dark, the whole peninſula was conſiderably elevated above the horizon, and viewed by all our company with admiration.—There was a ſingular appearance attending this phenomenon, which I do not remember to have ſeen taken notice of by any writer—the peninſula was frequently ſeen double, or rather two ſimilar peninſulas, one above the other, with an appearance of water between:—the ſeparation, and coincidence was very frequent, and not unlike that obſerved in ſhifting the index of an adjuſted Godfrey's quadrant.—As ſingular as this may appear, it is not more ſo than the double refraction produced by the Ice-Land cryſtal. The next morning Preſque-Iſle was again inviſible, and remained ſo during our ſtay at that poſition. Preſque-Iſle was about twenty-five miles diſtant, its ſituation very low.

The ſame evening the wind began to blow briſkly from about two points weſt of north, and continued to increaſe till the evening of the 14th, when it was more violent than any thing of the kind I had ever been witneſs to before, and continued till the evening of the 16th without the leaſt intermiſſion. Our tents were all blown down, and we were under the neceſſity of fortifying our camp, by driving poſts, near to each other, firmly into the ground on the windward ſide, and filling up the vacuities with buſhes in form of an hedge. During the continuance of this wind, we frequently obſerved ſmall black clouds hanging over the lake; they had but little velocity, and were ſometimes exhauſted, and diſappeared without reaching the ſhore.

From the large bodies of timber blown down about the lakes, it appears that hurricanes are not uncommon.—Coxe obſerves in his Travels through Ruſſia, that the lakes in that country are ſubject to terrible ſtorms.

IX. *An Account of the Sugar-Maple-Tree of the United States, and of the Methods of obtaining Sugar from it, together with Obſervations upon the Advantages, both public and private, of this Sugar.* By BENJAMIN RUSH, *M. D.*

THE *Acer Saccharinum* of Linnæus, or the Sugar Maple-tree, grows in great quantities in the weſtern countries of all the middle ſtates of the American Union. Thoſe which grow in New-York and Pennſylvania yield the ſugar in a greater quantity than thoſe which grow on the waters of the Ohio.—Theſe trees are generally found mixed with the beech[*], hemlock[†], white and water aſh[‡], the cucumber tree[§], linden[||], aſpen[**], butter nut[††], and wild cherry trees[‡‡]. They ſometimes appear in groves, covering five or ſix acres in a body, but they are more commonly interſperſed with ſome or all of the foreſt trees which have been mentioned. From 30 to 50 trees are generally found upon an acre of ground. They grow chiefly in the richeſt ſoils, and frequently in ſtony ground. Springs of the pureſt water abound in their neighbourhood. They are when fully grown as tall as the white and black oaks, and from two to three feet in diameter[¶]. They put forth a beautiful white bloſſom in the ſpring before they ſhew a ſingle leaf. The colour of the bloſſom diſtinguiſhes them from the acer rubrum, or the common maple, which affords a bloſſom of a red colour. The wood of the Sugar Maple-tree is of an inflammable nature, and is preferred upon that account by hunters and ſurveyors, for fire-wood. Its ſmall branches are ſo much impregnated with ſugar, as to afford ſupport to the cattle—horſes and ſheep of the firſt ſettlers during the winter, before they are able to cultivate forage for that purpoſe. Its aſhes afford a great quantity of pot-aſh, exceeded by few, or perhaps by none, of the trees that grow in the woods of the United States.

The tree is ſuppoſed to arrive at its full growth in the woods in twenty years.

It is not injured by tapping; on the contrary, the oftener it is tapped, the more ſyrup is obtained from it. In this reſpect it follows the law of animal ſecretion. A ſingle tree has not only ſurvived, but flouriſhed after *forty two* tappings in the ſame number of years. The effect of a yearly diſcharge of ſap from the tree in improving and increaſing the ſap is demonſtrated from the ſuperior excellence of thoſe trees which have been perforated in an hundred places, by a ſmall wood-pecker, which feeds upon the ſap. The trees after having been wounded in this way diſtil the remains of their juice on the ground, and afterwards acquire a black colour. The ſap of theſe trees is much ſweeter to the taſte than that which is obtained from trees which have not been previouſly wounded, and it affords more ſugar.

From twenty-three gallons and one quart of ſap procured in twenty hours from only two of theſe dark-coloured trees, Arthur Noble, Eſq. of the ſtate of New York, obtained four pounds and thirteen ounces of good grained ſugar.

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[*] Fagus Ferruginea.

[†] Pinus abies.

[‡] Fraxinus Americana.

[§] Magnolia acuminata.

[||] Tilia Americana.

[**] Populus tremula.

[††] Juglans alba (oblonga.)

[‡‡] Prunus Virginiana of Linnæus.

[¶] Baron La Hontan, in his voyage to North America, gives the following account of the Maple-tree in Canada. After deſcribing the black Cherry-tree, ſome of which he ſays are as tall as the lofticſt oaks, and as big as a hogſhead, he adds, "The Maple-tree is much of the ſame height and bulk. It bears no reſemblance to that ſort we have in Europe."

A tree of an ordinary ſize yields in a good ſeaſon from twenty to thirty gallons of ſap, from which are made from five to ſix pounds of ſugar. To this there are ſometimes remarkable exceptions. Samuel Low, Eſq. a juſtice of peace in Montgomery County, in the ſtate of New-York, informed Arthur Noble, Eſq. that he had made twenty pounds and one ounce of ſugar, between the 14th and 23d of April, in the year 1789, from a ſingle tree, that had been tapped for ſeveral ſucceſſive years before.

From the influence which culture has upon foreſt and other trees, it has been ſuppoſed, that by tranſplanting the Sugar Maple-tree into a garden, or by deſtroying ſuch other trees as ſhelter it from the rays of the ſun, the quantity of the ſap might be increaſed, and its quality much improved. I have heard of one fact which favours this opinion. A farmer in Northampton County, in the ſtate of Pennſylvania, planted a number of theſe trees above twenty years ago in his meadow, from *three* gallons of the ſap of which he obtains every year a pound of ſugar. It was obſerved formerly that it required five or ſix gallons of the ſap of the trees which grow in the woods, to produce the ſame quantity of ſugar.

The ſap diſtils from the *wood* of the tree. Trees, which have been cut down in the winter for the ſupport of the domeſtic animals of the new ſettlers, yield a conſiderable quantity of ſap, as ſoon as their trunks and limbs feel the rays of the ſun in the ſpring of the year.

It is in conſequence of the ſap of theſe trees being equally diffuſed through every part of them, that they live three years after they are *girdled*, that is, after a circular inciſion is made through the bark into the ſubſtance of the tree, for the purpoſe of deſtroying it.

It is remarkable, that graſs thrives better under this tree in a meadow, than in ſituations expoſed to the conſtant action of the ſun.

The ſeaſon for tapping the trees is in February, March, and April, according to the weather which occurs in theſe months.

Warm days and *froſty* nights are moſt favourable to a plentiful diſcharge of ſap*. The quantity, obtained in a day from a tree, is from five gallons to a pint, according to the greater or leſs heat of the air. Mr. Low informed Arthur Noble, Eſq. that he obtained near three-and-twenty gallons of ſap in one day (April 14, 1789,) from the ſingle tree which was before mentioned. Such inſtances of a profuſion of ſap in ſingle trees are however not very common.

There is always a ſuſpenſion of the diſcharge of ſap in the night, if a froſt ſucceed a warm day. The perforation in the tree is made with an ax or an auger. The latter is preferred from experience of its advantages. The auger is introduced about ¾ of an inch, and in an aſcending direction (that the ſap may not be frozen in a ſlow current in the mornings or evenings) and is afterwards deepened gradually to the extent of two inches. A ſpout is introduced about half an inch into the hole, made by this auger, and projects from three to twelve inches from the tree. The ſpout is generally made of the Shumach* or Elder †, which generally grow in the neighbourhood of the ſugar trees. The tree is firſt tapped on the *South* ſide; when the diſcharge of its ſap begins to leſſen, an opening is made on its *North* ſide, from which an increaſed diſcharge takes place. The ſap flows from four to ſix weeks, according to the temperature of the weather. Troughs, large enough to contain three or four gallons, made of white pine, or white aſh, or of dried water aſh, aſpen, linden, poplar ‡ or common maple, are placed under the ſpout, to receive the ſap, which is carried every day to a large receiver, made of either of the trees before mentioned. From this receiver it is conveyed, after being ſtrained, to the boiler.

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* The influence of the weather, in increaſing and leſſening the diſcharge of the ſap from trees, is very remarkable.

Dr. Tonge ſuppoſed long ago (Philoſophical Tranſactions, No. 68) that changes in the weather, of *every kind*, might be better aſcertained by the diſcharge of ſap from trees, than by weather-glaſſes. I have ſeen a journal of the effects of heat, cold, moiſture, drought, and thunder, upon the diſcharges from the ſugar trees, which diſpoſes me to admit Dr. Tonge's opinion.

To preſerve the ſap from rain and impurities of all kinds, it is a good practice to cover the troughs with a concave board, with a hole in the middle of it.

It remains yet to be determined whether ſome artificial heat may not be applied ſo as to increaſe the quantity and improve the quality of the ſap. Mr. Noble informed me, that he ſaw a tree, under which a farmer had accidentally burnt ſome bruſh, which dropped a thick heavy ſyrup reſembling Melaſſes. This fact may probably lead to ſomething uſeful hereafter.

During the remaining part of the ſpring months, as alſo in the ſummer, and in the beginning of autumn, the maple tree yields a thin ſap, but not fit for the manufactory of ſugar. It affords a pleaſant drink in harveſt, and has been uſed inſtead of rum, in ſome inſtances, by thoſe farmers in Connecticut, whoſe anceſtors have left to them, here and there, a ſugar maple tree (probably to ſhade their cattle) in all their fields. Mr. Bruce deſcribes a drink of the ſame kind, prepared by the inhabitants of Egypt, by infuſing the ſugar cane in water, which he declares to be " the moſt refreſhing drink in the world §."

There are three methods of reducing the ſap to ſugar. 1. By *freezing it.*—This method has been tried for many years, by Mr. Obadiah Scott, a farmer in Luzerne county, in this ſtate, with great ſucceſs. He ſays that one half of a given quantity of ſap, reduced in this way, is better than one third of the ſame quantity reduced by boiling. If the froſt ſhould not be intenſe enough, to reduce the ſap to the graining point, it may afterwards be expoſed to the action of the fire for that purpoſe.

2. By *ſpontaneous evaporation.* The hollow ſtump of a maple-ſugar tree, which had been cut down in the ſpring, and which was found ſome time afterwards filled with ſugar, firſt ſuggeſted this method of obtaining ſugar to our farmers. So many circum-

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* Rhus. † Sambucus Canadenſis. ‡ Liriodendrum Tulipifera.

§ Baron La Hontan gives the following account of the ſap of the ſugar maple tree, when uſed as a drink, and of the manner of obtaining it. " The tree yields a ſap which has a much pleaſanter taſte than the beſt lemonade or cherry water, and makes the wholeſomeſt drink in the world. This liquor is drawn by cutting the tree two inches deep in the wood, the cut being made ſloping to the length of ten or twelve inches: at the lower end of this gaſh a knife is thruſt into the tree ſlopingly, ſo that the water runs along the cut or gaſh, as through a gutter, and falls upon the knife, which has ſome veſſels placed underneath to receive it. Some trees will yield five or ſix bottles of this water in a day; and ſome inhabitants of Canada might draw twenty hogſheads of it in one day, if they would thus cut and notch all the maple trees of their reſpective plantations. The gaſh does no *harm to the tree.* Of this ſap they make ſugar and ſyrup, which is ſo valuable, that there can be no better remedy for fortifying the ſtomach; 'tis but few of the inhabitants that have the patience to make them, for as common things are ſlighted, ſo there are ſcarce any body but children that give themſelves the trouble of gaſhing theſe trees."

ſtances of cold and dry weather, large and flat veſſels, and, above all, ſo much time, are neceſſary to obtain ſugar, by either of the above methods, that the moſt general method among our farmers is to obtain it, 3. by *boiling*. For this purpoſe the following facts, which have been aſcertained by many experiments, deſerve attention.

1. The ſooner the ſap is boiled, after it is collected from the tree, the better. It ſhould never be kept longer than twenty-four hours, before it is put over the fire.

2. The larger the veſſel in which the ſap is boiled, the more ſugar is obtained from it.

3. A copper veſſel affords a ſugar of a fairer colour than an iron veſſel.

The ſap flows into wooden troughs, from which it is carried and poured into ſtore troughs or large ciſterns, in the ſhape of a canoe or large manger, made of white aſh, linden, baſs wood, or white pine, from which it is conveyed to the kettle in which it is to be boiled. Theſe ciſterns, as well as the kettle, are generally covered by a ſhed, to defend the ſap from the rain. The ſugar is improved by ſtraining the ſap through a blanket or cloth, either before or after it is half boiled. Butter, hog's lard, or tallow, are added to the ſap in the kettle, to prevent its boiling over; and lime, eggs, or new milk, are mixed with it in order to clarify it. I have ſeen clear ſugar made without the addition of either of them. A ſpoonful of ſlacked lime, the white of one egg, and a pint of new milk, are the uſual proportions of theſe articles which are mixed with fifteen gallons of ſap. In ſome ſamples which I have lately ſeen of maple-ſugar clarified with each of the above articles, that in which milk alone was uſed had an evident ſuperiority in point of colour.

The ſugar, after being ſufficiently boiled, is *grained* and *clayed*, and afterwards *refined*, or converted into loaf ſugar. The methods of conducting each of theſe proceſſes are ſo nearly the ſame with thoſe which are uſed in the manufactory of Weſt-India ſugar, and are ſo generally known, that I need not ſpend any time in deſcribing them.

It has been a ſubject of inquiry, whether the maple ſugar might not be improved in its quality, and increaſed in its quantity, by the eſtabliſhment of boiling-houſes in the ſugar maple country, to be conducted by aſſociated labour. From the ſcattered ſituation of the trees, the difficulty of carrying the ſap to a great diſtance, and from the many expences which muſt accrue from ſupporting labourers and horſes in the woods in a ſeaſon of the year in which nature affords no ſuſtenance to man or beaſt, I am diſpoſed to believe that the moſt productive method, both in quantity and profit, of obtaining this ſugar will be by the labour of private families. For a great number of years many hundred private families in New-York and Pennſylvania have ſupplied themſeleves plentifully with this ſugar during the whole year. I have heard of many families who have made from two to four hundred pounds in a year; and of one man who ſold ſix hundred pounds, all made by his own hands in one ſeaſon*.

The writer then gives a comparative view of the maple-ſugar, with that of the Weſt India ſugar-cane, with reſpect to *quality*, *price*, and *quantity*. 1. Its *quality* is better than that of Weſt India ſugar, as being prepared when there are no inſects, or duſt, or pollen of plants to foul it. It is alſo made by more cleanly perſons. Its ſuperior purity is proved by leaving a leſs ſediment when diſſolved. A ſuſpicion has been entertained that the maple-ſugar is inferior in ſtrength to the Weſt India; but from the faireſt experiments this does not appear to be the caſe. 2. The ſugar-maple-tree being a ſpontaneous and abundant product, and the ſugar being obtained by the labour of the farmer's own family, without the expence of mills, ſlaves, cattle, &c. there ſeems no reaſon to doubt that it can be ſold at a leſs *price*. 3. The reſources for *quantity* will appear from conſidering, that in the States of New York and Pennſylvania alone, there are at leaſt ten millions of acres which produce the ſugar-maple-tree at the proportion of 30 trees to an acre. Suppoſe the perſons capable of labour in a family to be three, and each to attend 150 trees, and each tree to produce five pounds of ſugar, and 60,000 families to engage in the making of it, the product would be 135 millions of pounds; of which if 120 millions are conſumed in the States, it will leave 15 millions for exportation. The number of families, here ſtated as making ſugar, will appear large, but more than double the number are employed in the more troubleſome proceſs of making cyder. Moreover, ſugar is not the only product of the maple. Melaſſes and excellent vinegar are produced from the ſap which flows later in the year.

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* *The following receipt, publiſhed by William Cooper, Eſq. in the Albany Gazette, fully eſtabliſhes this fact*:

" Received, Cooper's Town, April 30th, 1790, of William Cooper, ſixteen pounds, for ſix hundred and forty pounds of ſugar made with *my own hands*, without any aſſiſtance, in leſs than four weeks, beſides attending to the other buſineſs of my farm, as providing fire-wood, taking care of the cattle, &c. John Nicholls. Witneſs, R. Smith."

A ſingle family, conſiſting of a man and his two ſons, on the maple ſugar lands, between the Delaware and Suſquehannah, made 1800lbs. of maple ſugar in one ſeaſon.

The writer next conſiders the advantages of a large admixture of ſugar in diet. 1. It affords a greater quantity of nutriment than any other ſubſtance in the ſame bulk; and is of uſe in fattening horſes and cattle, as well as for the human ſpecies. 2. It is one of the beſt preventatives of worms in children. 3. It probably is a preſervative from malignant fevers. 4. It is uſeful in diſorders of the breaſt, and acrid defluxions upon other parts of the body.

In order to tranſmit to future generations the advantages ariſing from the ſugar-maple-tree, Dr. R. propoſes that it ſhould be protected from the new ſettlers by a law, or a bounty on the ſugar, or ſhould be tranſplanted from the woods, and cultivated in orchards; and he makes ſome calculations of the profits which would accrue to the planters. He conſiders it in the light of humanity, as a moſt important gift for the future prevention of the cultivation of ſugar by ſlaves in the Weſt Indies.

To this letter is annexed a paper from the report of the Engliſh Privy Council for trade, on the mode of cultivating a ſugar plantation in the Eaſt Indies, by freemen.

X. *Memoir of* Jonathan Williams, *on the Uſe of the Thermometer in diſcovering Banks, Soundings*, &c.

MR. W. in 1785, was fellow-paſſenger with Dr. Franklin from Europe to America, and made, under his directions, the experiments mentioned in his deſcription of the *Gulph ſtream*, publiſhed in theſe Tranſactions, vol. 2. He determined to repeat theſe experiments in future voyages; and accordingly in a paſſage from Boſton to Virginia, October 1789, he kept a journal of the heat of the air and water at ſunriſe, noon, and ſun-ſet. He noticed that the ſea water out of ſoundings was about 10 degrees warmer than on the coaſt; when it occurred to him, that the thermometer might be an uſeful nautical inſtrument to indicate an approach to ſhore. On this idea, he continued his experiments in three more voyages, viz. from Virginia to England, from England to Halifax, and from Halifax to New-York. From his journals and obſervations in theſe voyages, it appears not only that Dr. Franklin's account of the warmth of the gulph ſtream is amply confirmed, but that banks, coaſts, iſlands of ice, and rocks under water, may be diſcovered with no other trouble than dipping the thermometer into water. As we do not think it neceſſary to copy the journals themſelves, we ſhall give the writer's ſtatement of the facts which his experiments ſeem to eſtabliſh.

1. The water over banks is much colder than the water of the main ocean, and it is more cold in proportion as it is leſs deep.

2. The water over ſmall banks is leſs cold than that over large ones.

3. The water, over banks that are near the coaſt, is warmer than that over banks far diſtant, but it is colder than the adjacent ſea.

4. The water over banks of the coaſt, *i. e.* thoſe immediately connected with the land above water, is warmer than that over thoſe which admit deep water between them and the coaſt; but ſtill it is colder than the adjacent ſea.

5. The water within capes and rivers does not follow the above rules: it being leſs agitated, and more expoſed to the heat of the ſun, and to receive the heat from the circumjacent land, muſt be colder or warmer than that in ſoundings without, according to the ſeaſons, and temperature of the atmoſphere.

6. The paſſage, therefore, from deep to ſhoal water, may be diſcovered by a regular uſe of the thermometer, before a navigator can ſee the land; but as the temperature is relative, no particular degree can be aſcertained as a rule, and the judgment can only be guided by the difference. Thus in Auguſt I found the water off Cape Cod to be 58° by Fahrenheit, and at ſea it was 69°; in October the water off Cape Cod was 48°, and at ſea it was 59°. This difference was equally a guide in both caſes, though the heat was different at different ſeaſons.

I do not preſume to ſay what is the cauſe of this difference of heat between the ſea and bank water; but if a navigator were to obſerve it when near an iſland of ice, he would very naturally ſay that the ice conducted the heat from the circumjacent water, and left it colder than that at a diſtance. And as it is well known that ſtones and ſand are great conductors of heat, it ſeems probable that banks alſo conduct the heat from the adjacent water, though not ſo rapidly as the ice. The heat of the water may indeed be ſuppoſed to ſeek its equilibrium; but as long as the iſlands of ice and banks continue to conduct, there muſt be ſome difference, and this it is, which, by attention, may be made a faithful ſentinel to give an alarm when danger is near.

The journal A. from Boſton to Virginia, ſhows that the water, on the coaſt of Maſſachuſetts, was at 48°; at ſea between that coaſt and the ſtream, 59°; in the gulph ſtream, at its edge, 67°; between that, and the coaſt of Virginia farther ſouthward, 64°; and in ſoundings on that coaſt, 56°. At that ſeaſon (in October, juſt after the warm weather) the water grew warmer as we approached the land.

The journal B. from Virginia to England, ſhows that, in December, the water in the coaſt of Virginia was at 47°; between the coaſt and the ſtream, 60°; and in the ſtream, 70°. This current being in our favour, we did not avoid it, and the water continued with little variation, till we came near the banks of Newfoundland, when the thermometer fell from 66 to 54; paſſing theſe, it roſe again to 60°, and then continued a very gradual deſcent as we went to the Northward, till we ſtruck ſoundings, when it was at 48°.

It may be here obſerved, that the decreaſe in the heat of the water was ſo gradual as to give but one degree in a day's run; while in going to, or coming from the coaſt of America, the thermometer will alter 8 or 10 degrees in a few hours run. It is well known, by ſounding, that the Engliſh coaſt extends with a very gradual deſcent, to a great diſtance. It is alſo known that the American coaſt does not extend very far, and the water is ſuddenly deep. Let theſe facts be compared with the changes in the thermometer, on the two coaſts, and they will agree with what has been ſaid about the uſefulneſs of that inſtrument.

It may be obſerved in Doctor Franklin's journal on board of the Repriſal, that in November 1776, when near the banks of Newfoundland, his thermometer fell ten degrees, though conſiderably to the Southward of them, and after paſſing them, it roſe nearly to its former ſtate: the Doctor did not make any obſervation on this circumſtance; but it agrees with my journal, in nearly the ſame place, made nine years afterwards.

The journal C. from England to Halifax, ſhows the changes in the heat of the water, as we ſailed over banks and deep water alternately, with an accuracy that, I confeſs, exceeded my expectation, the land appearing as the thermometer indicated our approach to it.

The journal D. from Halifax to New-York, not only ſhows the variety of depths we paſſed over, but indicates the inner edge of the gulph ſtream. As by the thermometer and ſoundings it appeared to me that the ſhip was a-head of the reckoning, I made allowances for the eddy current of that ſtream in our favour, and comparing theſe with the chart, I noted in the journal the longitude I thought we were in, under that calculated by the ſhip's officers: what encouraged this opinion, was the diſagreement between the ſoundings by the lead, and thoſe marked on the chart in the places where, by the common reckoning, the ſhip was ſuppoſed to be; while upon the other ſuppoſition they both agreed. When we made the land, this latter reckoning turned out accurate, and I won a ſmall bet of the Captain, who candidly acknowledged the uſefulneſs of the thermometer, and declared that he would in future always have one on board.

Finding the coaſt of America to grow ſuddenly deep as it approaches the gulph ſtream, and finding continued ſoundings from Cape Sable to New-York, I am induced to believe that it has its ſhape according to the courſe of that current, and that it is connected in a ſweep from the banks of Newfoundland to Florida, the various banks between being only eminences of the coaſt. If my apprehenſion of the accuracy of thermometrical obſervation is well founded, it would be an eaſy thing to make a general ſurvey of the coaſt under water, more particularly than has hitherto been, or could be done by ſounding.

In an annexed chart the edge of the gulph ſtream is traced as far as the banks of Newfoundland. How much farther Eaſtward it runs, he does not determine; but having found a current in the direction of its ſweep among the Weſtern Iſlands, he conceives it to extend thus far before it turns ſouthwards. In confirmation of what has been ſaid about the eddy of the gulph ſtream, he gives ſome extracts from a journal kept on board the Britiſh ſhip of war, Liverpool, and adds other extracts deſcribing a current among the Weſtern Iſlands.

Some experiments are added with reſpect to the heat of fiſh, made July, 1790, in lat. 44. 52. Several codfiſh and hallibut being caught, the thermometer was put into them the inſtant they were drawn up, and fell to 37. In one inſtance, when the fiſh was firſt gutted, it was one degree higher. The air at the ſame time was 57, and the water at the ſurface 53. He ſuppoſes, that the water at the bottom was at leaſt as cold as the animal heat of the fiſh; and one reaſon for imagining it colder, was the great diſtenſion of the cods' ſounds when opened, though they had ſent out innumerable bubbles of air in the paſſage upwards. The air in the ſounds muſt therefore have been compreſſed by cold, or the power of the animal.

XI. *An Account of the moſt effectual Means of preventing the deleterious Conſequences of the Bite of the Crotalus Horridus, or Rattle-Snake.* *By* BENJ. SMITH BARTON, *M. D.*

THE writer, on a tour through the weſtern ſettlements, made it his buſineſs to gain every poſſible information reſpecting the bite of the rattle-ſnake, its effects and cure. He found that a variety of vegetables were popularly reckoned *good for the bites of ſnakes*, but among theſe were articles of the moſt oppoſite qualities; and he was well aware of circumſtances which, at times, render the bites of the moſt venomous ſerpents harmleſs. On examining the matter more minutely, he found reaſon to believe, that notwithſtanding the principal confidence is placed in internal medicines, yet that the external treatment was really the moſt important. In general, the firſt thing done, after a perſon was bitten, was to throw a tight ligature above the wounded part, where capable of ſuch an application. The wound was then ſcarified, and ſalt and gunpowder, either ſeparately or mixed, was laid on it. Over the whole was applied a piece of the bark of the white walnut, which acts as a bliſter. At the ſame time, one or more of the vegetables thought ſpecific are given in decoction or infuſion, along with large quantities of milk. By theſe drinks a ſtrong perſpiration is excited, which undoubtedly may be of ſome ſervice. This is eſpecially effected in a violent degree by the juice of garden rue, which the Indians in Jerſey give in the doſe of two table-ſpoonfuls every two hours. But the external means are firſt employed, which operate in preventing further abſorption of the venom into the ſyſtem, and evacuate that already admitted, by promoting diſcharges of blood and ſerum. When the venom has through neglect been ſo far abſorbed as to affect the next conglobate glands, Dr. B. adviſes the ſcarification of theſe glands, at the ſame time applying ſome veſicatory of ſtrong and ſpeedy operation, of which he knows none more likely to be effectual than the *Ecorce de Garou* of the French, or bark of the *Daphne Gnidium*.

Sometimes the poiſon, inſtead of being conveyed to the blood through the ſlower channel of the lymphatics, is at once thrown into a vein or artery. In this caſe its effects are repreſented as moſt rapid, and uſually fatal. The ligature, and the uſe of rue or ſome ſtrong ſudorific, ſeem here to afford the moſt probable means of relief. The Creek Indians generally practiſe ſucking the wound made by a rattle-ſnake, and ſome of the tribes cut out the part.

The ſymptoms of the introduction of this poiſon into the blood, are nauſea, a full, ſtrong, agitated pulſe, ſwelling of the whole body, eyes entirely ſuffuſed with blood, often, hæmorrhages from the eyes, noſe and ears, and ſometimes copious bloody ſweats. The teeth chatter, and the pains and groans of the ſufferer indicate approaching diſſolution. In this ſtate, little ſeems capable of being done by medicine. The poiſon of the rattle-ſnake is generally of a yellowiſh, ſomewhat greeniſh, colour, which becomes darker in hot weather. It is obſerved to be more active during the coupling ſeaſon.

The writer cloſes his paper with ſtrongly recommending an attention to the ſimple preventive means in this and other poiſons, and with warning the obſerver againſt looking out for *ſpecifics*. A credulity in this reſpect ſtill adheres to ſome reſpectable writers, among whom M. le Page du Pratz, and even Linnæus, are enumerated. A liſt of vegetables, recommended by the Indians or Whites in this caſe, is ſubjoined. The greater part of theſe are of the bitter and ſtimulant tribe.

XII. *Magnetic Obſervations, made at the Univerſity of Cambridge (Maſſachuſetts), in the Year* 1785. *By Dr.* S. WILLIAMS.

Months.	Days.	Greateſt variation.	Days.	Leaſt Variation.	Difference.	Mean Variation at 7 A. M.	Mean Variation at 1½ P. M.	Mean Variation at 9 P. M.
January	15 1½ P. M.	6° 50′	2 31 9 P. M.	6° 28′	3½′	6° 36′	6° 42′	6° 34′
February	25 1½ P. M.	6 39	23 9 P. M	5 49	50	6 34	6 39	6 32
March	1 1½ P. M.	6 52	1 9 P. M	6 28	24	6 36	6 39	6 36
April	19 ½ P. M.	7 12	25 9 P. M.	6 20	52	6 34	6 53	6 34
May	3 6 1½ P. M.	7 5	2 7 A.M.	6 28	45	6 38	6 55	6 38
June	7 18 1½ P. M.	7 8	20 9 P. M.	6 29	39	6 44	6 57	6 40
July	11 28 1½ P. M.	7 11	18 7 A.M.	6 33	38	6 46	7 1	6 49
Auguſt	6 21 1½ P. M.	7 13	31 7 A.M.	6 25	48	6 42	7 2	6 48
Septem.	11 30 1½ P. M.	6 55	8 7 A.M.	6 13	42	6 32	6 46	6 34
October	18 1 P. M.	7 11	5 7 A.M.	6 27	44	6 48	6 55	6 43
Novem.	2 5 1 P. M	6 59	29 9 P. M.	6 17	42	6 44	6 50	6 38
Decem.	1 4 1 P. M	6 58	19 7 A.M.	6 28	30	6 43	6 50	6 39
In the Year.	Aug. 6 and 21.	7 13	February 23.	5 49	1 24	6 40	6 51	6 39

The above Obſervations were made with an excellent variation-inſtrument, with a twelve inch needle.

XIII. *Accurate*

XIII. *Accurate Determination of the Right Aſcenſion and Declination of* β *Bootes, and the Pole Star: in a Letter from Mr.* ANDREW ELLICOTT *to Mr.* R. PATTERSON. *October* 17, 1788.

THE declination of β Bootes was determined by comparing its zenith diſtance with the zenith diſtances of α Lyræ, α Cygni, γ Andromedæ, β Meduſæ, and δ Cygni. The right aſcenſion was determined by comparing its paſſage over the meridian, with the moſt convenient of thoſe contained in the 10th table, annexed to the firſt volume of Maſkelyne's Aſtronomical Obſervations. The right aſcenſion and declination of the Pole Star were deduced from Maſkelyne's Obſervations. In the following tables, when the ſun's place, or place of the moon's aſcending node is on the left ſide of the firſt column, uſe the ſign on the left ſide of the column required, and *vice verſa*.

The Right Aſcenſion and Declination of β Bootes, to the beginning of 1789.

	S	°	′	″		″
Right Aſcenſion,	7	13	30	3,5	Ann. Var.	+34. 1
Declination,		41	13	47,94	Ann. Var.	—14. 53

Sun's Place and Place of the Moon's Aſcending Node. S. D. S.	Aberration in R. Aſcenſion.	Aberration in Declination.	Nutation in R. Aſcenſion.	Nutation in Declination.
O. VI.	″	″	″	″
0	+17. 70—	—14. 30+	+6. 07—	—6. 57+
10	20. 61	12. 34	3. 93	5. 57
20	22 90	10. 17	1. 59	4. 41
I. 0 VII.	24. 48	7. 61	—0. 79+	3. 10
10	25. 32	4. 81	3. 09	1. 71
20	25. 40	1. 87	5. 30	0. 26
II. 0 VIII.	24. 70	+1. 13—	7. 43	+1. 19
10	23. 25	4. 10	9. 39	2. 62
20	21. 09	6. 94	10. 21	3. 96
III. 0 IX.	18. 30	9. 57	12. 10	5. 18
10	14. 95	11. 90	12. 92	6. 24
20	11. 14	13. 88	13. 43	7. 11
IV. 0 X.	6. 99	15. 44	13. 51	7. 77
10	2. 61	16. 53	13. 11	8. 19
20	—1. 79+	17. 11	12. 38	8. 36
V. 0 XI.	6. 18	17. 11	11. 30	8. 28
10	10. 37	16. 72	9. 83	7. 95
20	14. 30	15. 75	8. 03	7. 37
VI. O.	17. 70	14. 30	6. 07	6. 57

The Right Aſcenſion and Declination of the Pole Star to the beginning of the year 1789.

	S	°	′	″		″
Right Aſcenſion,	0	12	32	7,06	Ann. Var.	+ 183,03*
Declination,		88	10	40,8		+ 19,4

Sun's Place and Place of the Moon's Aſcending Node. S.	D.	S.	Aberration in R. Aſcenſion.	Aberration in Declination.	Nutation in R. Aſcenſion.	Nutation in Declination.
O.		VI.	′ ″	″	′ ″	″
	0		—9. 19+	+3. 72—	—4. 49+	+2. 11—
	10		9. 34	0. 27	5. 00	0. 86
	20		9. 32	—3. 18+	4. 54	—0. 41+
I.	0	VII.	9. 12	6. 54	4. 43	1. 67
	10		8. 35	9. 69	4. 23	2. 86
	20		7. 43	12. 56	3. 55	3. 98
II.	0	VIII.	6. 35	15. 04	3. 20	4. 98
	10		5. 18	17. 07	2. 39	5. 82
	20		3. 50	18. 57	1. 55	6. 49
III.	0	IX.	2. 15	19. 51	1. 4	6. 96
	10		0. 36	19. 86	0. 13	7. 22
	20		+1. 40—	19. 61	+0. 39—	7. 26
IV.	0	X.	2. 42	18. 75	1. 29	7. 08
	10		4. 16	17. 30	2. 17	6. 69
	20		5. 41	15. 39	3. 1	6. 09
V.	0	XI.	6. 57	12. 97	3. 39	5. 31
	10		7. 59	10. 16	4. 9	4. 36
	20		8. 47	7. 05	4. 34	3. 28
VI.		O.	9. 19	3. 72	4. 49	2. 11

* The Right Aſcenſion of the Star (independent of the Ann. Var.) muſt be increaſed by an arithmetical progreſſion, the firſt term and common difference of which is 1″.01, and the number of terms will be the years elapſed ſince 1789.—As for example, let it be required to find the Right Aſcenſion of the Pole Star, on the 1ſt of January, 1800. Then 1.″01 × 11 = 11.″11 the laſt term, and 11.″11 + 1.″01 = 12.″12 = the ſum of the extremes;—then $\frac{12''12}{2}$ × 11 = 66.″66, which is the ſum of the progreſſion,—then the Annual Variation 183″.03 × 11 = 2013″.83 = 33,33,″ this added to 0s. 12° 32′ 7″. 06. will give 0s. 13° 5′ 40.″ 39, and this ſum increaſed by the ſum of the progreſſion 1′ 6.″ 66. will give 0s. 13. 6′ 47.″ 05, for the mean Right Aſcenſion of the Star: but if the Right Aſcenſion of the Pole Star is required before the beginning of the year 1789, then the Ann. Var. and Sum of the progreſſion will be deductive.

XIV. *Account*

XIV. *Account of ſeveral Houſes in Philadelphia, ſtruck with Lightning, on June 7, 1789.*

By Mr. DAVID RITTENHOUSE *and Dr.* JOHN JONES.

THE moſt remarkable circumſtance reſpecting the two houſes ſtruck, of which a figure is given, is, that the lightning deſcended the funnels of two chimneys that had fire in them, and did not paſs through two contiguous ones. Alſo, it quitted near the top that which had the leaſt fire, but came the whole way down that which had the moſt. This fact ſeems to favour the opinion, that the rarefaction of bodies diſpoſes them to be conductors of electricity, and that rarefied air is a good conductor. A practical inference is, that during a thunder-ſtorm it is ſafer to be near a chimney without fire, than one that has fire.

XV. *Account of the Effects of a Stroke of Lightning on a Houſe furniſhed with two Conductors.*

By Meſſrs. D. RITTENHOUSE *and* FR. HOPKINSON.

A HOUSE, ſituated near a mill-dam, at the foot of a pretty ſteep aſcent, with ſtacks of chimneys at each end, and a pointed conductor ariſing from each, was ſtruck by lightning, Auguſt 17, 1789. The lightning came down the weſtern conductor, which it ſeems to have left in conſequence of the attraction of a water-gutter, covered with copper, and running along the roof from weſt to eaſt, and at the eaſt end connected with a copper ſpout deſcending along the wall to a water tub. The electric fluid ruſhed in two ſtreams from the conductor to the copper gutter, and ſhewed its effects at the intervals of communication by ſome miſchief in the roof and cornice. Part of it, however, was diſcharged by the conductor into the earth. The following remarks cloſe the paper.

This caſe ſeems to give ſome force to an objection made long ago to the uſe of pointed rods. That is, that they may ſometimes invite a diſcharge of the electric matter, which would otherwiſe have paſſed elſewhere, and which they are neverthleſs inſufficient to convey, without injury to the building. But it is by no means certain that the houſe would have eſcaped had it not been furniſhed with rods; for we very often ſee the lightning ſtrike low trees and buildings in the neighbourhood of others much higher; and, beſides, had not the copper gutter and ſpout furniſhed ſuch an excellent conductor, the fluid might have paſſed quietly through one or both of the rods. But by whatever means the diſcharge was promoted in that particular manner, the damage done to the building was trifling, and no part of the inſide ſuffered in the leaſt, notwithſtanding that the ſtroke, by the prodigious noiſe which accompanied it, ſeemed to be very powerful.

It is remarkable that a perſon was ſitting at the time in a door on the ground floor, not more than four feet from the lower end of the copper ſpout, who received no injury, though he very ſenſibly felt the ſhock.

From our obſervations on the above caſe, as well as ſome others that have occurred, we would ſtrongly recommend to thoſe who put up pointed rods, that the lower end be ſunk ſufficiently deep to reach moiſt earth in the drieſt ſeaſons. And we ſubmit it to thoſe converſant with electrical philoſophy, whether, when there are more rods than one to a building, it might not conduce much to its ſafety, to form a good communication between the rods, and likewiſe between them and a copper water ſpout; carrying an iron or copper rod from the lower end of the ſpout a ſufficient depth into the ground.

XVI. *Experiments and Obſervations on Evaporation in Cold Air.* By C. WISTAR, *M. D.*

DURING an experiment with a frigorific mixture, I frequently had occaſion to introduce my hand, when it was wet, into a cold veſſel, and obſerved, that while it was in this ſituation, a ſmoke or viſible vapour aroſe from the moiſture on it, which ceaſed when it was withdrawn into warmer air, and returned upon my replacing it in the veſſel.

In order to obſerve this proceſs with more accuracy, I fixed an empty tin jar in a tub, and filled the tub with a mixture of ſalt and ſnow, ſo that the veſſel was completely ſurrounded with the mixture, and the air in it was ſoon reduced to the temperature of ſalt and ſnow, or to 0° of Fahrenheit's ſcale.

In this ſituation, I ſuſpended in it a rag which had been dipped in water of the temperature of 40°—as ſoon as it deſcended within the veſſel, it began to emit ſmoke or ſenſible vapour, and continued doing ſo a conſiderable time.—While ſmoking, it was drawn out, and the ſmoke ceaſed.—After this, it was replaced in the veſſel, and again began to ſmoke.

This was repeated frequently, and always with a ſimilar reſult, ſo that I had no doubt of the fact.—In the firſt caſe in which I obſerved this ſmoke to ariſe, the moiſt body muſt have enjoyed a heat of 98°, or near it, as it was my hand; by this experiment it appeared that a moiſt body of 40° would ſmoke alſo in the ſame circumſtances, and I now wiſhed to know whether this would be the caſe with a body ſtill colder.—For this purpoſe a ſmall piece of ice was ſuſpended in the veſſel, as the rag had been before—it ſmoked when firſt ſuſpended there; this ſmoking ceaſed when it was drawn out, and returned when it was placed in the veſſel again; preciſely as it had happened when the rag was uſed.—Another lump of ice was dropped into the veſſel, and allowed to remain there; it ſmoked for twelve or fifteen minutes, and then ceaſed.—Snow ſmoked in the ſame manner, but not ſo long.

To be certain that this vapour really aroſe from the ice, a ſmall mirror was ſuſpended horizontally in the cold veſſel. It continued ſo a long time without contracting any moiſture or dullneſs on its ſurface. The ice was then introduced under it; and, although there was a conſiderable diſtance between them, the mirror ſoon became encruſted with hoar froſt. To prevent deception, I varied this experiment by placing a tumbler inverted in the cold veſſel. It remained there a long time, and its ſurface, both within and without, continued free from any moiſture or froſt. I then introduced under it a piece of ice, and in a few minutes the whole internal ſurface was covered with froſt.

This proved clearly that the vapour aroſe from the ice alone; and during this experiment, another fact of the ſame nature occurred. When the mirrors or tumblers

were

were removed from the cold veſſel into the air of the room, which was 34°, they ſoon attracted moiſture from it, which appeared on their ſurfaces in the form of ice or froſt; they were replaced in the veſſel when thus encruſted, and the ice ſoon diſappeared, their ſurfaces becoming as bright as before.

The whole of this proceſs was pleaſing:—while the mirror remained in the cold veſſel, its ſurface continued bright; very ſoon after it was placed in the air of the room, it became dull, as if breathed upon; this dullneſs increaſed to an evident moiſture, conſiſting of ſmall drops of water: a fibre of ice then formed ſuddenly in the moiſture, a ſecond appeared to ſhoot from this, a third from the ſecond, and ſo on, until the whole was congealed. When this congelation was completed, the mirror was returned to the cold veſſel, and the ice diſappeared in about the ſame ſpace of time in which it had formed.

This collection of moiſture on the ſurfaces of bodies cooled to 0°, and then expoſed to air of 34°, is analogous to the formation of drops of water on the ſurfaces of cool bodies expoſed to the warm air of ſummer: it proves, that even in cold weather, a large quantity of moiſture exiſts in our atmoſphere.

When the ice was in the cold veſſel, I obſerved that it ſmoked but about twelve or fifteen minutes, and ſuſpected that perhaps the evaporation continued no longer: to determine this point, I placed two tumblers in the cold veſſel, and when they were cooled, placed a lump of ice in the ſame ſituation, and inverted one of them over it; this tumbler became encruſted with froſt as before; it remained twenty minutes, and then being removed, the other was inverted over the ice in its place; but although the ſecond tumbler remained a long time in this ſituation, its ſurface continued perfectly free from any moiſture or ice whatever. This reſult appeared to me a full proof that the actual, as well as the apparent evaporation, ceaſed in a few minutes after its commencement; but from the whole of the experiments, I was induced to believe, that, while the evaporation went on, it was much more rapid in the cold veſſel, than in the open air, which was ſo much warmer. To determine this accurately, two lumps of ice, of the ſame weight and form, ſhould have been expoſed a given time, one to the air of the veſſel, and the other to the air of the room, and then weighed accurately; but having no nice ſcales, I was reduced to another expedient much leſs exact. As moiſture is very conſpicuous on mirrors or poliſhed ſurfaces, I thought of comparing one of them which had been moiſtened, and placed in the cold veſſel, with another which had been equally moiſtened, but placed in warmer air: for this purpoſe I took two razors highly poliſhed, and, after expoſing them to my breath, ſo that each was equally dull, I placed one of them in the cold veſſel, and at the ſame time held the other in air of 34°. In ſeveral inſtances the razor in the cold air loſt its moiſture ſooneſt, and in ſome other inſtances, both of them loſt their moiſture ſo quickly, that it was difficult to compare them.

I refrain, however, from drawing a concluſion from theſe reſults, becauſe when the ſame razors were expoſed to my breath, and then placed, both of them in air of 34°, one loſt its moiſture in leſs time than the other. Although this circumſtance leſſened my confidence in the reſult of the laſt experiments, it may be explained upon the ſame principles which explain the others: in the mean time it is certain, that when both razors, after being cooled to 0°, were moiſtened with my breath, and in that ſituation expoſed, one to the open air of 34°, and the other to the air of the cold veſſel, that which was in the veſſel loſt its moiſture, while that in the open room appeared to receive additional moiſture from the air around it.

That evaporation continues when the air is below 32, has been long known; but from the above experiments it would appear, that it goes on faſter in a cold veſſel than in the air of the room. This may probably be explained as follows. Water evaporates by three proceſſes: 1. When expoſed to air of its own temperature, or warmer, it diminiſhes inſenſibly. 2. If its heat be in a certain degree above that of the air, a viſible vapour will ariſe from it. 3. When heated to 212, the motion called boiling is produced, which conſiſts in the aſcent of globules of elaſtic vapour, which, on eſcaping from the water into the air, yield a viſible inelaſtic vapour, or ſmoke. The evaporation, produced by the immerſing moiſt bodies or ice in cold air, reſembles the ſecond of theſe proceſſes. The ſmoking of water has by M. De Luc been aſcribed to the paſſage of heat or fire from the moiſt body to the ſurrounding air, carrying with it ſome water diſſolved in it. This hypotheſis is rendered probable by the following facts, which occurred during the above experiments.

1. The ice ſmoked for a few minutes only, after it was dropped into the cold air.

2. The ſecond tumbler, which was inverted over the ice, continued perfectly free from any moiſture or froſt, although the firſt was lined with it.

3. If one of the razors, when placed in the cold veſſel, was encruſted with a ſmall quantity of ice or moiſture, this moiſture would ſoon diſappear; but if it was in large quantity, a part only would diſappear, and the remainder continue unchanged, although the razor was kept a long time in the cold veſſel.

Now it is probable, that in the firſt and ſecond of theſe inſtances, the evaporation commenced as ſoon as the heat began to flow from the ice to the air, and ceaſed as ſoon as the ice was reduced to the temperature of the air, or as ſoon as the motion of the heat ceaſed.

The ſame, I believe, happened to the ice on the razor, but the razor being a ſmall body could have contained but little heat, of courſe therefore the evaporation from it muſt have ceaſed before much ice could have been removed.

Several facts may be explained by this principle. Thus Crantz, in his account of Greenland, ſays, that when the cold is very intenſe, the ſea reeks like an oven, and that this ſmoke is by the inhabitants called *froſt-ſmoke*. This explanation will alſo become more probable, if it can be made to appear, that a proceſs, the reverſe of evaporation, depends upon a contrary principle. This is, the collection of moiſture upon the ſurfaces of cold bodies expoſed to warm air, which Dr. Franklin explains upon the ſuppoſition, that the water in the atmoſphere is combined with heat, and is collected on the cold ſurface in conſequence of the paſſage of this heat into the cold body. The following experiment confirms this idea, by proving its converſe; that is, that when a body is *not* in a condition to receive heat from the atmoſphere, no moiſture can collect upon it. A mirror breathed upon when below 98, or animal heat, is at once covered with a miſt; but on heating one a little above 98, not the leaſt moiſture could be fixed upon it, though applied cloſe to the mouth, and breathed upon frequently.

XVI. *Poſt-*

XVI. *Poſtſcript to Mr.* BARTON'*s Letter on Population.*

A CENSUS of all the United States having been publiſhed ſince Mr. B.'s firſt paper was written, the following remarks are ſuggeſted by it. By the cenſus, it is found, that the entire number of free white male inhabitants, in all the ſtates, collectively, is, to the number of that deſcription under ſixteen years of age, in the ſame, as 100 of the former to 49.52 of the latter: and it may be preſumed, that nearly the ſame ratio obtains among the females. It is alſo found, that the number of free white male, to that of the free white female inhabitants, in all the ſtates, collectively (and including therewith, the South-Weſtern territory), is, as 100 of the former to 96.35 of the latter.

Although there are in the United States (taking the South-Weſtern territory, likewiſe, into the calculation) nearly 59,000 more free white males than free white females; yet it appears, that the States of Maſſachuſetts, Rhode-Iſland, and Connecticut, contain nearly 9,000 more of the latter than of the former. In general, there is the higheſt proportion of females in thoſe States, *from* which there have been the greateſt emigrations; becauſe more men than women migrate: hence we find the higheſt proportions of males in Kentuckey, Vermont and the South-Weſtern territory, *to* which the moſt numerous migrations have recently been made.

We obſerve, alſo, the higheſt proportions of perſons under ſixteen years of age, in the States of Kentuckey, North-Carolina, Georgia, South-Carolina, and Virginia; where the population is thin, in compariſon with the extent of territory, and where—owing to the facility of acquiring lands, from which ample and certain ſubſiſtence is readily obtained—people marry earlier in life, and produce the more children.

The ſame obſervations will apply to the ſtate of Pennſylvania. This ſtate contains twenty-one counties: the capital contains the higheſt proportion of females to males: the nine oldeſt counties, comprehending the moſt populous part of the ſtate, and excluding the capital, have a lower proportion of females; the eight counties next ſettled, in point of time, give one ſtill lower; and the four counties, laſt ſettled, give the loweſt proportion of all.

This order is directly inverted, with reſpect to the ratio of perſons under ſixteen years of age, to the intire number of all ages, in thoſe ſeveral ſections of this ſtate; the four tranſmontane counties containing the higheſt proportion of males under ſixteen, and the city of Philadelphia having the loweſt.

XVII. *New Notation of Muſic. By Mr.* R. PATTERSON.

THE purpoſe of this writer's propoſal is to make the common printing types ſerve for muſical notation, in order to avoid the trouble and expence of copper-plate impreſſions of muſic according to the common method. His deſign is thus explained. In muſical ſounds two things are to be conſidered, *tone* and *time.* The latter, according to the common notation, is denoted by peculiar characters appropriated to the different lengths or intervals of the muſical ſounds, and the tones themſelves by lines and ſpaces on which the aforeſaid characters are placed. Muſicians have been long agreed to denominate theſe lines and ſpaces by the ſeven firſt letters of the alphabet : now if the tones of muſical notes, inſtead of being repreſented by lines and ſpaces, were denoted by the letters which denominate theſe, and their times by the common ſtops or marks of pauſe in reading, ſubjoined to the letters, this notation of muſic would certainly be as natural as the common one, and would moreover have this great advantage, that muſic might then be printed with the common alphabetical types; by which means all the inconvenience and expence attending the publication of muſic, according to the uſual notation, would be avoided; a magazine or common newſpaper would then become a convenient vehicle for publiſhing the moſt celebrated airs or pieces of muſic (which any one might afterwards, if he ſhould think it neceſſary, prick off for himſelf in the common form) and thus contribute to diffuſe a more general knowledge of this ornamental and humanizing ſcience.

To explain this matter fully. Let the ſeven notes, a, b, c, d, e, f, g, on one of which the cliff is placed, be printed in ſmall Roman letters; the ſeven notes next above theſe, in ſmall Italics; the next ſeven, when any of them ſhall occur, in Italic capitals; and the ſeven notes below the cliff-octave, in Roman capitals. Theſe four octaves, viz. A, B, C, D, E, F, G; a, b, c, d, e,f, g; *a*, *b*, *c*, *d*, *e*, *f*, *g*; *A*, *B*, *C*, *D*, *E*, *F*, *G*; will be more than ſufficient to expreſs all the compaſs of tone on any particular cliff. The governing flats or ſharps, which are uſually placed at the beginning of a tune, when tranſpoſed from its natural key; as alſo the cliff, time, mood or other circumſtance, may be expreſſed in words at length after the title of the tune. Accidental flats, ſharps, and naturals, to deviate as little as poſſible from the common notation, I would expreſs as follows : the flat by a ſmall b, placed before the note affected, and ſet a little higher than the other letters in the line. This may be done either by uſing a letter of a ſmaller body and ſpacing it up, or by what printers call a *ſuperior letter*, ſuch as are commonly uſed for notes of reference. The poſition and ſize of this b will ſufficiently diſtinguiſh it from the note of that name. The aſteriſm, or, if it ſhould be thought better, a ſmall x, placed before the note, will very well expreſs an accidental ſharp; and the letter n, a natural; and though theſe characters for ſharps and naturals can never be miſtaken for notes, yet for the ſake of uniformity, and to prevent all poſſible embarraſſment in reading, I would place them alſo a little higher than the other letters in the line. Two or more notes ſounded together, as is frequent on clavicords, harps and other ſtringed inſtruments, may be expreſſed by ſetting ſuch notes one over the other.

As for the times of notes, which is the ſecond thing to be conſidered in muſical ſounds, they may, I think, be very naturally expreſſed by the following marks, which are uſed for a ſimilar purpoſe in common reading.

Semi-demi-quavers, which are ſung or played as rapidly as the ſyllables of a word are pronounced, may be expreſſed by the hyphen (which, in reading, only ſeparates ſyllables) placed after ſuch notes, (-)

Semi-quavers, by the comma (,)
Quavers, by the ſemicolon (;)

Crotchets, by the colon (:)
Minims, by the period (.)
And ſemi-breves by the m daſh (—)

A pricked note may be expreſſed, as in common notation, by an inverted period ſet after the mark, ſignifying the time of the note.

When two or more notes of equal time come together in the ſame bar, the mark of time need only be expreſſed after the laſt of ſuch notes, and underſtood to the reſt; and the different ſyllables in a bar may, when it is thought neceſſary, be diſtinguiſhed by interpoſing a ſpace between ſuch ſyllables.

Reſts will be very well expreſſed by the foregoing reſpective marks of time ſet alone, or not immediately preceded by a note.

A ſingle bar may be intelligibly expreſſed by the m daſh ſet ſide-wiſe acroſs the line. |

A double bar by what printers call a parallel. ||

A repeat by a parallel, or the letter S, placed between two colons. :||: :S:

All the common marks of graces in muſic may be very well expreſſed or imitated by the common printing types: thus a *trill*, by tr, ſet above the note; a *beat*, by the aſteriſk +, and a *turn*, by the letter S turned ſide-wiſe ∽, and ſet above their reſpective notes; a *ſlur*, by incloſing the ſlurred notes in a parentheſis ( ); *ſtaccato-notes* by a period or hyphen ſide-wiſe, ſet over, or under ſuch notes; a *pauſe*, by a parentheſis and period together, ſet ſide-wiſe, over the note 𝄐; *diminutives, or notes of tranſition*, as they are not counted in the time of the bar, will be very naturally expreſſed by encloſing ſuch notes in a paratheſis. [ ]

When three notes are reduced to the time of two, or ſix to the time of four, the figure 3 or 6 may be reſpectively ſet above ſuch notes, as in the common notation.

All terms of execution or expreſſion, as adagio, andante, piano, forte, &c. and figures marking the chords in thorough baſs, may be alſo expreſſed as in the common notation.

XVIII. *Obſervations on the Theory of Water Mills*, by W. WARING. *Read June 15, 1792.*

THREE different velocities are to be conſidered, when a ſtream of water impinges againſt a wheel in motion. 1ſt. The abſolute velocity of the water. 2d. The abſolute velocity of the wheel. 3d. The relative velocity of the water to that of the wheel, or the difference of the abſolute velocities.

Now, writers in general, on the theory of mills, ſuppoſe, that the force of the water againſt the wheel is in the duplicate ratio of the relative velocity; whereas, the ſtream being invariable, and the wheel in motion, the force is only in the ſimple direct proportion of that velocity. For, the number of particles acting on one of the planes in a given time, and the momentum of each particle being reſpectively as the relative velocity, the force, according to the common theory, muſt be in the duplicate ratio of their relative velocity with reſpect to this ſingle plane: but the number of planes acted on in a given time is as the velocity of the wheel, or inverſely as the relative velocity, therefore the moving force of the wheel muſt be in the ſimple direct ratio of the relative velocity. Or by another proof, whatever is the velocity of the wheel, the ſame number of particles muſt ſtrike it ſomewhere or other in a given time ; conſequently the variation of force is only on account of the varied impingent velocity of the particles, occaſioned by a change of motion in the wheel, that is, the momentum is as the relative velocity.

The importance of this correction may be ſeen in the following inſtances.

To produce the greateſt poſſible effect, the velocity of the wheel muſt be half the velocity of the ſtream. Let V be the velocity, M the momentum of the fluid, v the velocity, P the power of the wheel. Then $V - v =$ the relative velocity, and $V : V - v :: M : \frac{M}{V} \times V - v = P$, and $Pv = \frac{M}{V} \times \overline{Vv - v^2} =$ maximum $\therefore Vv - 2vv = 0 \therefore v = \frac{1}{2} V$. According to the common theory $v = \frac{1}{3} V$. Mr. Smeaton (Phil. Tranſ. for 1776, p. 457), though not acquainted with the true theory, was aware of the miſtake in the common mode ; for he ſays, that "the maximum lies "much nearer one half than one third, one half ſeeming to be the true maximum, "if nothing were loſt by the reſiſtance of the air, the ſcattering of the water carried "up by the wheel, &c."

Let M (*plate* 5, *fig.* 3) be the momentum, V the velocity of the fluid at I, the place of impact $IS = R$, $DS = r$ the radius of the ſmall wheel on the ſame ſhaft, W the weight or reſiſtance to be overcome at D, and F the force neceſſary to move the wheel without the weight, required the velocity x of the wheel.

$V : V - x :: M : M \times \frac{V - x}{V} =$ acting force at I in the direction KI, and $R : r :: W : \frac{rW}{R} =$ power at I to counterpoiſe the weight $W \therefore \frac{rW}{R} + F =$ reſiſtance to the ſtream at $I \therefore M \times \frac{V - x}{V} - \frac{rW}{R} - F =$ accelerating force of the machine, which, when the motion becomes uniform, is evaneſcent, or $= 0 \therefore M \times \frac{V - x}{V} = \frac{rW}{R} + F \therefore x = V \times \overline{1 - \frac{rW}{MR} - \frac{F}{M}}$ or rejecting the force F, $x = V \times \overline{1 - \frac{rW}{MR}}$. But by the common theory $x = V \times \overline{1 - \sqrt{\frac{rW}{MR}}}$ which is too little by $V \sqrt{\frac{rW}{MR}} - V \frac{rW}{MR}$.

To find W ſuch as juſt to admit of that velocity, which would produce the greateſt effect, ſubſtitute $\frac{1}{2} V$ for its equivalent x, and $\frac{1}{2} V = V \times \overline{1 - \frac{rW}{MR} - \frac{F}{M}} \therefore W = \frac{\frac{1}{2} M - F}{r} \times R$, or if $F = 0$, $W = \frac{MR}{2r}$; by the common theory $W = \frac{4MR}{9r}$, making an error $= \frac{MR}{18r}$. Alſo $r = \frac{\frac{1}{2} M - F}{W} \times R$ or $F = 0$, $r = \frac{MR}{2W}$, but by the common theory $r = \frac{4MR}{9W}$.

XIX. Aſ-

XIX. *Aſtronomical Obſervations, communicated by* DAVID RITTENHOUSE.

Obſervations of a Lunar Eclipſe, Nov. 2, 1789, at the Univerſity of William and Mary, by the Rev. Dr. JAMES MADISON.

NOV. 2d. A mean of the correſponding altitudes taken this day, made the clock 17′, 17″ ſlower than apparent time; to which 9″½ being added for change of declination in the half interval, hence the clock was ſlow of the ſun, 17′ 26″ 30‴

Obſervations of the Lunar Eclipſe.

	App. H.	Time. ′	″
Penumbra—thought to touch the ☽ at	6	8	46
Eclipſe begins	6	21	0
Tycho begins to immerge	6	38	45
Wholly immerged	6	43	
Shadow reaches mare nectaris	7	34	0
Tycho begins to emerge	7	57	44
Wholly emerged	8	1	26
End of the eclipſe.	8	30	0

Theſe obſervations were made with an achromatic teleſcope, magnifying about 60. —The immerſion and emerſion of Tycho were particularly noted, as thoſe times may be more accurately aſcertained, than either the beginning or end of a lunar eclipſe— The weather was remarkably favourable for aſtronomical obſervations.

Obſervations of the Tranſit of Mercury, Nov. 5.

The 1ſt internal contact was not ſeen. When I firſt diſcovered ☿, he was ſomewhat advanced upon the ſun's limb, and had an oval appearance, the longer axis directed towards the body of the ſun.—But at 8ʰ. 3′. 10″ the planet ſuddenly aſſumed a round figure, and the firſt internal contact was accordingly noted.

The 2d internal contact, - - - - - - 12. 53. 42.

The 2d external contact could not be determined with any tolerable accuracy on account of the remarkable undulatory motion which appeared upon the ſun's limb, ſoon after the 2d internal contact. Mercury diſappeared to me, at, 12ʰ 55′ 2″. I made uſe of an achromatic, magnifying about 150.

Mr. Andrews, profeſſor of mathematics, with a reflector made by Short, and with a magnifying power of 90—made the following obſervations.

The 2d internal contact - - - - 12ʰ 53′ 48″
2d external contact - - - 12 55 19

The ſame undulatory appearance was not ſeen in the reflector, and therefore the 2d external contact obſerved by it, may be more relied upon—The times of our obſervations were taken from the ſame clock, but noted in different rooms—The day was remarkably favourable, being clear, and ſufficiently calm.

By *D. Rittenhouſe*, at *Philadelphia.*

Lat. 39°. 57′. 10″. Long. weſt of Greenwich 5h. 0′. 35″.

November, 2d, 1789. Moon eclipſed.

Beginning - -	6h 12′	P. M. mean time.
End at - -	8 20	
Digits eclipſed, - -	4½	

Tranſit of Mercury, November 5th, 1789.

Firſt external contact - -	7h 51′ 50″	A. M.	mean time.
Internal - -	7 53 20		
Second internal contact - -	12 43 24	P. M.	
End of the tranſi - -	12 45 4		

The undulation of the ſun's limb was ſo great that no micrometer meaſures could be taken with accuracy, but the leaſt diſtance of the centres ſeemed to be 7′.-15″.

October 22, 1790. Moon eclipſed.

Beginning at - -	5h. 41′. ″	P. M. mean time.
Beginning of total darkneſs -	6. 49. 9	
End of total darkneſs -	8. 30. 16	
End of the eclipſe - -	9. 37. 25	

November 6, 1790. Sun eclipſed.

Beginning at - -	12h. 2′ 55″	P. M. mean time.
End at - - -	2. 1 54	

Mayer's tables advance the eclipſe 33″. Maſon's new tables 29″. By Mayer's tables the limbs were ſeparated 8″ before the end of the eclipſe, by Maſon's the eclipſe was ſtill remaining 6″. Maſon places the moon's nodes 51″ more forward, but the eclipſe is beſt repreſented by retaining Mayer's place of the node.

Tranſit of Mercury, obſerved at Waſhington College, November 5th, 1789. By the Rev. Dr. *William Smith.*

N. B. The clock was cleaned and ſet a going P. M. November 4th, its rate of going, as to mean time, uncertain; but at ſun riſe November 5th, as nearly as could be gueſſed, it was about 2. 30″ faſter than apparent time.

External contact -	8. 3. 50″	A. M.
Internal - -	8. 5. 0	Magnifying power 95.

Micrometer meaſures of neareſt limbs.

h	′	Inch.	16ths.	20ths.	500ths.	′	″
9.	19 =	0.	6.	1.	19. =	6.	4
	54 =	0.	9.	0.	0. =	7.	57
10.	31 =	1.	0.	0.	0. =	8.	50
	53 =	0.	9.	1.	9 =	8.	23
11.	38 =	0.	7.	0.	6 =	6.	17
12.	0 =	0.	5.	0.	20 =	4.	46

Second internal contact	12h. 55′. 10	Magnifying power 130.
Total egreſs	12. 56. 35	

	h	′	Inch.	10ths.	20ths.	′ ″
☉'s diameter at	12.	15. =	3	6	1 =	= 32′ 14,5

Annular Eclipſe of the Sun, April 3d, 1791. Obſerved at Philadelphia, by *D. Rittenhouſe.*

Beginning (ſun juſt above the horizon) about	5h. 45′. 30″	A. M. Mean time.
Ring formed nearly, at - - -	6. 50. 30	
The ring broken - -	6. 54. 47	
End of the eclipſe - -	8. 7. 2	

At the middle of the eclipſe the ring was nearly twice as broad at the ſouth ſide as at the north ſide.

XX. *Method of finding the Sum of the ſeveral Powers of the Sines. By Dr.* RITTENHOUSE.

MAKE a fraction, whoſe denominator is the index of the given power, and its numerator the ſame index, diminiſhed by unity, and multiplied by the ſquare of the radius: by this fraction multiply the ſum of the next but one lower power, and we have the ſum of the given power.

Thus 1ſt, the ſum of the firſt power of the ſines is = rr, or the ſquare of the radius
2d, ſum of the 2d power or ſquares is = $\frac{1}{2}$ rr × by the arch of 90°.
By Demonſtration.

3d, ſum of the 3d power or cubes is $\frac{2}{3}$ rr of the 1ſt or = $\frac{2}{3}$ r^4.
4th, ſum of 4th powers is = $\frac{3}{4}$ rr of the 2d or = $\frac{3}{8}r^4$. × by the arch of 90°.
5th, ſum of 5th powers is = $\frac{4}{5}$rr of the 3d, or = $\frac{8}{15}r^6$.
6th, ſum of 6th powers is = $\frac{5}{6}$rr of the fourth or = $\frac{5}{16}r^6$. × by arch of 90°.
By Infinite Series.

7th, ſum of 7th powers is = $\frac{6}{7}$ rr of the 5th, or = $\frac{16}{35}r^8$.
8th, ſum of 8th powers is = $\frac{7}{8}$rr of the 6th, or = $\frac{35}{128}r^8$. × by the arch of 90°.
By the Law of Continuation.

&c. &c.

A demonſtration of the third and ſubſequent caſes is requeſted, and the writer was led to inveſtigate this method by the diſcovery of a very elegant theorem for determining the times of vibration of a pendulum, in given arches of a circle, which required the ſolution of this problem.

XXI. *Index Floræ Lancaſtrienſis, Auctore* HENRICO MUHLENBERG, *D. D.*

THIS is a catalogue of the plants growing wild or cultivated, in or near Lancaſter, in Pennſylvania, diſpoſed according to the Linnean ſyſtem. The number of Genera noted is 454.

XXII. *Inveſtigation of the Power of Dr.* BARKER'S *Mill, as improved by* JAMES RUMSEY, *with a Deſcription of the Mill. By* W. WARING. *Read Sept.* 21, 1792.

INTO the tube R T (plate 5, fig. 4) the water is conveyed by a pipe, from the head H through N. C., and by paſſing off at the apertures m, n, on contrary ſides, a rotation is made round the axis PX, which turns the upper millſtone M.

Let e = area of the water's paſſage at N.
h = the perpendicular height of H above N.
u = the perpendicular depth of any part of the pipe below H.
x = the area at the depth u.

$x : e :: \sqrt{h} : \sqrt{u} \therefore x = e\sqrt{\frac{h}{u}} \therefore$ the pipe muſt widen towards the head H in the proportion of $1 : \sqrt{\frac{h}{u}}$, and if x is leſs than $e\sqrt{\frac{h}{u}}$ the water will be obſtructed in its paſſage.

Let a = area of either aperture.
h = height of the water above the centres of the apertures, in feet.
w = 62,5 lb. avoirdupois = weight of a cubic foot of water—To find
I the force with which the machine begins to move.

Previous to the opening of the apertures, there is not any motion, becauſe the action againſt each ſide is the ſame, therefore the preſſure againſt the part m to be removed, is equal to that oppoſed to the ſame area e in the oppoſite direction: m being opened, its reaction ceaſes, and the equal impulſe remaining on the contrary ſide e = ahw is the force required for each arm ∴ I = 2hwa.

Let x = diſtance of any point in the radius from the centre of motion.
r = length of the arm.
t = time of a revolution in ſeconds.

$wa\dot{x}$ = the weight of the evaneſcent quantity of water paſſing through the tube at right angles to its direction, and by the doctrine of central forces $t^2 : 1{,}228x :: aw\dot{x} : \frac{1{,}228aw x\dot{x}}{t^2}$ = the centrifugal force at x feet from the centre of motion, or the fluxion of the centrifugal force of the quantity paſſing through either arm at any time $\therefore \frac{76{,}75\,ar^2}{t^2}$. = central force of the water in both arms.

A particle P (plate 5, fig. 5.) moving uniformly in C A, which moves uniformly from A to B, deſcribes the common ſpiral of Archimedes, and the velocities in P and Q are as the radii CP, CQ, as are alſo the times of moving from C to P, Q. The particle P being therefore uniformly accelerated in the direction Pn, its reaction againſt the moving line C A, muſt be the ſame in every point from C to A, and the middle point of the radius is to be conſidered as the centre of reſiſtance.

Let x = CP, v = vel. of P per ſecond in direction CA, c = 3,1416.

Then the moving plane or particle $P = a\dot{x}$ and its weight $wa\dot{x}$, its velocity $= \frac{2cx}{t}$ and the time of paſſing from C to $P = \frac{x}{v}$: the accelerating force to communicate this velocity in the time $\frac{x}{v} = \frac{cwav\dot{x}}{16t}$ = the fluxion of the inertia, whoſe fluent, when x becomes r, $= \frac{12{,}272,\,avr}{t}$ = the reſiſtance to either arm, ſuppoſed accumulated at $\frac{1}{2}$r from the centre of motion, and conſequently equal to the effect at both apertures, when reduced to their diſtance.

The velocity of the water through the apertures at the beginning of rotation is $64h \therefore 2wah : 64h :: 2awh + \frac{76{,}75ar^2}{t^2} : 64h + \frac{39{,}296r^2}{t^2}$ = the ſquare of the augmented velocity.

By ſubſtituting $8\sqrt{(h + \frac{.614r^2}{t^2})}$ for v, in $\frac{12,272avr}{t}$ it becomes $\frac{98,176ar^2}{t^2} \times \sqrt{(\frac{bt^2}{r^2} + .614)}$ = the inertia, and as the central force $\frac{76,75ar^2}{t^2} : \frac{98,176ar^2}{t^2} \times \sqrt{(\frac{bt^2}{r^2} + .614)} :: 1 : 1,28\sqrt{\frac{bt^2}{r} + .614} = \sqrt{(1 + \frac{1.638bt^2}{r^2})}$; in this proportion is the power gained by centrifrugal force to obſtruction occaſioned by the inertia; therefore the longer the arms, the leſs the fall of water, and the greater the velocity of rotation are, the nearer do theſe forces approach the ratio of equality.

The centrifugal force ſhould not exceed the gravity of the rotating water, or this water would be drawn into the tube faſter than the natural ſupply at its entrance, by the velocity proper to that depth; conſequently muſt loſe the preſſure of the column above it: nor ſhould the velocity of the apertures be greater than half that of the water through them; for the apertures being ſtill adapted to the velocity, the effluent quantity or number of acting particles is as the time; conſequently the momentum is in the ſimple ratio of the relative velocity as before demonſtrated for the underſhot wheel: hence, the greateſt effect will be produced when the central force = gravity, and the velocity of the apertures = $\frac{1}{2}$ that of the water; that is, $\frac{76,75ar^2}{t^2} = 2war$; and, $\frac{2cr}{t} = 4\sqrt{b + r}$. from which equations we have the following.

Viz. $\left\{\begin{array}{l} h = 3r = 5t^2 \\ r = 1.63t^2 = \frac{1}{2}h \\ t = v.614r = v\frac{1}{3}h \end{array}\right\}$ nearly, where we find, h, r, and t^2, about the conſtant ratio of 5, 3 and 1.

Let $614r = t^2$ and $3r = b$ and the expreſſion $\sqrt{(1 + \frac{1,638bt^2}{r^2})} = \sqrt{1 + 3} = 2$; and the reſiſtance of inertia is double the central force, which is $\overline{125ar}$, and taken from the impelling force leaves $62,5(ab + r) - 125ar = 62,5a \times \overline{b - r} = 41\frac{2}{3}ab$ avoirdupois lb (if $r = \frac{1}{3}b$) = the real moving force at the diſtance of the centres of the aper tures from the centre of motion.

Let A = area of a ſection perpendicular to the direction of its motion, V = its velocity per ſecond, both in feet, then $AV = 8a\sqrt{b - \frac{.614r^2}{t^2}}$ cubic feet = quantity of water emitted per ſecond, and $a = \frac{AV}{18,47\sqrt{b}}$ the area proper for one of the apertures.

Hence are deduced the following eaſy practical rules:

1. Make the arm of the rotatory tube, from the centre of motion to the centre of the aperture, of any convenient length, not leſs than $\frac{1}{3}$ of the perpendicular height of the water's ſurface above theſe centres.

2. Multiply the length of the arm, in feet, by .614, and take the ſquare root of the product for the proper time of a revolution in ſeconds, and adapt the other parts of the machinery to this velocity; or,

3. If the time of a revolution be given, then, multiply the ſquare of this time by 1.63 for the proportional length of the arm.

4. Multiply together the breadth, depth, and velocity per ſecond of the race, and divide the laſt product by 18,47 times the ſquare root of the height, for the area of either aperture.

5. Multiply the area of either aperture by the height of the head of water, and the product by $41\frac{2}{3}$ (or by 40 on common occaſions) for the moving force, eſtimated at the centres of the apertures in pounds avoirdupois.

6. The power and velocity at the apertures may be eaſily reduced to any part of the machinery by the common rules of mechanics.

XXIII. *A Thermometrical Journal of the Atmoſphere and Sea, on a Voyage to and from Oporto, with Explanatory Obſervations thereon.*

THIS journal was kept by Captain Billings, of Philadelphia, and the remarks upon it are by Mr. Jonathan Williams, author of the paper on the ſame ſubject, No. X. of this volume. The following are the moſt important.

By theſe journals it appears, that in June 1791 the water on the coaſt was at the temperature of 61° by Fahrenheit, and in the Gulph ſtream at 77°. By my journals it will be found, that in November 1789 the water on the coaſt was at 47°, and in the Gulph ſtream, at 70°, viz.

By Capt. Billings, 1791,		By my experiments, 1789,		Differ. between June and November.
June, coaſt —	61	November, coaſt	47	14°.
Do. ſtream —	77	Do. ſtream	70	7
Do. ſtream warmer	16	Do. ſtream warmer	23	

Hence it may be concluded, that, although this difference of heat is more remarkable in winter than in ſummer, yet it is ſufficient at all times to guide navigators, ſo as to take the benefit of its current in going from, and to avoid its oppoſition in coming to, America. In the latter caſe, it has this additional convenience, in correcting a reckoning; for, if a navigator can, by this means, know the moment he is within the ſtream, he knows at the ſame moment his relative ſituation as to the coaſt; and if by repeated experiment this mode of correction ſhould be found ſolid, it amounts, in effect, to a certainty of the longitude, at the preciſe time when it is important to be accurate.

Captain Billings' courſe being nearly along the ſtream, he found only ſuch alteration in the heat of the water as may be accounted for by the cooling of the ſtream itſelf, in its courſe to the northward, till he came to lat. 39. 00. N. long. 56. 00. W. (a-breaſt of the Banks of Newfoundland) when the mercury fell 10°. Doctor Franklin, in November 1776, on board of the Repriſal, in lat. 41. N. long. 46. W. found about the ſame difference; but the Repriſal had kept a courſe farther ſouth, and came into this cool water in a N. N. E. direction; while Captain Billings being farther North, came in an eaſterly direction, and of courſe might be as much within the influence of that chain of banks which extends from the long. 45. W. along the American coaſt, as the Repriſal was when ſo much farther to the eaſtward. In November

1789, I found the ſame difference in lat. 40. N. long. 49. W. after ſailing in a direction about N. E. and a line being drawn from the place where Captain Billings' change happened, to that where Doctor Franklin's thermometer fell (in a direction about E. N. E.) would nearly interſect the place where I obſerved the ſame alteration; this is about the ſweep of the banks, known by frequent ſounding, as will be found by conſulting the beſt charts. By the coincidence of theſe three journals, at ſo great a diſtance of time, and without any knowledge of, conſequently without any connection with each other, this important fact ſeems to be eſtabliſhed. *A navigator may diſcover his approach towards objects of danger, when he is at ſuch a diſtance as to be able eaſily to avoid them, by attentively examining the temperature of the ſea.*

After having paſſed the banks, Captain Billings found but little difference during eighteen days ſail, till he came near the European coaſt. The ſame uniformity appears in my journal on a voyage to England, page 85 of this volume.

Captain Billings found the water to grow cooler three days before he made the land, and the mercury fell gradually from 65 to 60°, when the land appeared: this was in June. In November, I found on approaching the Engliſh coaſt, a gradual fall from 53 to 48°, and then we ſtruck ſoundings. Here the difference between the ſea and coaſt water was in both caſes the ſame, though the heat of both varied with the ſeaſon.

Returning from Oporto, Captain Billings marked his approach to, and departure from the Weſtern Iſlands, by the changes of his thermometer, but in this caſe the difference was ſmall; becauſe, owing to the climate and ſize of theſe iſlands, the land cannot be ſo cold as a northern continent naturally muſt be. Indeed, the uſefulneſs of the thermometer ſeems to be applicable to the more dangerous ſituations, and not to iſlands in warm climates. I ſhould ſuppoſe, for obvious reaſons, that the changes would not be great about the iſlands ſituated between the tropics. The ſhore of theſe iſlands is generally bold, and the land being very high, may be ſeen at a great diſtance. The climate is not ſubject to fogs, ſnow-ſtorms, iſlands of ice, long nights, &c. ſo that, except hurricanes (which are more fatal to ſhips in port than at ſea), there ſeems to be but little danger in ſuch navigation.

After leaving the Weſtern Iſlands, Captain Billings ſteered to the weſtward, being in nearly the ſame latitude on the 30th (37° 47° N.), that he was on the 17th of Auguſt (37° 53° N.): but during the intermediate time he was driven, as winds prevailed, in a zig-zag courſe, as far north as 39° 04 N. and as far ſouth as 36° 26 N. It appears alſo during this time that his thermometer varied from 1° to 5°; but it is to be remarked, that there is a medium in his thermometrical variations anſwering to the medium of his latitude. When he was in 39° 04, the thermometer marked 75°, and when in 36° 26, it alſo marked 75°, but when in 38° 12. it marked 70°. Now, conſidering that he had the warm influence of the gulph ſtream to the northward, and that the ocean water to the ſouthward muſt naturally be warmer than that more north, out of the ſtream, there ſeems to be a perfect agreement between theory and fact with regard to the uſefulneſs of the thermometer, in diſcovering the courſe of this current. The ſame thing occurred in the courſe of my paſſage in the London packet with Doctor Franklin (ſee vol. ii. page 329, of the Tranſactions of this ſociety), in June 1785. The mean there was 73, while to the northward and ſouthward the thermometer marked 77.

Returning towards the coaſt of America, Captain Billings diſcovered his paſſage acroſs the gulph ſtream by a ſudden fall in the mercury of 5° from noon to night, and about 5° farther weſt, by a further fall in the ſpace of eight hours run, he diſcovered the coaſt, where he got ſoundings, before he ſaw the land.

XXIV. *Firſt Memoir of Obſervations on the Plants denominated Cryptogamick.* By *M.* De Beauvois.

THIS paper is introduced by ſome obſervations in favour of the univerſality of ſexual regeneration, even in thoſe claſſes of nature in which it has been doubted or denied. The writer then, proceeding to a particular conſideration of the tribe of *moſſes*, notices thoſe organs in them, which by analogy may be conſidered as bloſſoms. The two queſtions to be decided reſpecting theſe, are, whether theſe parts are in fact their ſexual organs; and what are the uſe and nature of each in regard to the functions attributed to them. He begins the ſolution of theſe queſtions by a deſcription of the parts, illuſtrated by figures.

Explanation of Plate V.

1. The calyx (perichœtium) of only one piece, at the bottom of the tube.
2. The ſame of many pieces, or folioles.
3. The flower of the *Fontinalis*, ſurounded by the calycine folioles.
4. The cawl (calyptra) of the *Bryum extinctorium* of Linnæus.
5. Another ſpecies of cawl, which is more common.
6. The hairy cawl of the *Polytricum*.
7. The complete flower of the *Hypnum*.
8. The ſame in the *Mnium Polytrichoides* (Linn.), the cawl of which is hairy.
9. A very ſmall tubular corolla, the opercule of which is obtuſe. *Sphagnum*.
10. A corolla, of which the opercule is conic. *Hypnum*, *Bryum*, *&c*.
11. A corolla, of which the opercule is pointed. *Bryum*, *Mnium*.
12. A corolla, the opercule of which is in the form of a chapiter, flattened at the baſe. *Polytrichum*.
13. A corolla, the opercule of which is in the form of a chapiter, rounded at the baſe. *Bryum*.
14. The corolla, ſtalk, leaves and root of the *Phaſcum*.
15. The corolla of the *Polytrichum commune*, opened after its exploſion.

A. A thread ſhut up in the tube.
B. The tube opened.
C. The calyx.
D. The flower opened.
E. The capſule torn off, after maturity.
F. The apophyſis.

16. The corolla of the *Hypnum velutinum* (Linn.) opened after the eſcape of the pollen.

A. The pollen, or fecundating powder.
B. The capſule, ſurrounded with the fecundating powder.
C. The calyx.

17. The corolla of the *Hypnum* at the moment of fecundation.

A. The interior cills.
B. The exterior cills.

18. An horizontal portion of the urn, ſeen with the microſcope.

A. The epidermis.
B. The fecundating powder.
C. The capſule and ſeeds.

Of the Moſſes.

The fructification of theſe vegetables, commonly known by the name of *anthera*, or urn, is uniform and conſtant in all the family. It has the ſhape of a little club, more or leſs elongated (See Fig. 3. 7. 14.).

It is compoſed

The *Perichætium.*	of a ſingle piece in the form of a tube, in the *Bryum*, the *Mnium*, and *Polytricum* (Fig. 1. 8A. Fig. 15. C.): of ſeveral pieces, or foliola, more or leſs imbricated, as in the *Hypnum* and the *Fontinalis* (Fig 3. 7. 16. C.).
An Anthera, or Urn.	It is ſeſſile in the *Phaſcum* and the *Fontinalis* (Fig. 3. 14.): ſtanding upon a filament of different lengths in the *Bryum*, the *Hypnum*, the *Polytricum*, the *Splachnum*, and the *Mnium* (Fig. 7. 13.).

The urn, before its maturity, is compoſed

Of an *Operculum*, or Opercule:	more or leſs ſubulated in almoſt every one (Fig. 9. 13.); and in the form of a chapiter of a column in the *Polytricum*, and ſome ſpecies of the *Bryum* (Fig. 12. 13.).
Of a *Calyptra*, or Cawl.	It is ſmooth, and more or leſs tranſparent in the greater part (Fig. 4, 5, 7.): hairy and coloured in the *Polytricum*, and in the *Mnium Polytrichoides* (Fig. 6. 8.). There is none in the *Sphagnum*, and it is very caducous in the *Phaſcum*.

When theſe parts are ripe, the opercule and calyptra fall off; then the urn appears mutilated at its extremity, and the orifice, or opening, is either naked, or covered with cilia.

The writer having paid particular attention to the moſſes in their different ſtates and periods, he gives the following reſult:

I found that what the naturaliſts have conſidered as a thread, or filament, ſupporting the urn, is, in fact, a real tube, continued to the urn, which is a part, and the end, of it. I denominated the whole a corolla. This tube being carefully opened with a very ſharp penknife, diſcovers a white tranſparent filament, extending itſelf to the urn (Fig. 15. A.). The urn being opened, in like manner, when fully ripe, is found to contain the fragments of the dilacerated capſule (Fig. 15. E.). Theſe fragments are of the ſame colour and nature as the filament contained in the tube.

After having diſcovered theſe veſtiges of an unknown organization, I was deſirous of obſerving the ſame in the urn before the emiſſion of the pollen. I made choice of the *Polytricum commune* of Linnæus, as being larger and more proper for my obſervations. I took off the opercule, without injuring the other parts, and, for this purpoſe, I always preferred a bloſſom almoſt ripe. I then opened the urn on the ſide; I carefully took out the pollen, and by this method I diſcovered an oval body, of an herbaceous colour, ſituated in the centre. This kind of capſula, as I call it, is ſtrongly fixed to the bottom of the urn, and although I did not obſerve it ſticking to the internal filament, I am much inclined to think it is the termination of it. At another time, I cut off, horizontally, a part of a ripe bloſſom, and expoſing it to a magnifying glaſs, I diſcovered, 1. the epidermis of the corolla, (Fig. 18. A.); 2d. the pollen ſurrounding the capſule (Fig. 18. B.); 3d. ſmall globules ſitting between the fibres of a kind of net, which appeared to me to be the ſeeds, (Fig. 18. C.). Theſe obſervations I have ſucceſſively repeated on all the moſſes to be found in the neighbourhood of Paris, and Liſle, in Flanders; and I obſerved, with ſatisfaction, that every one, without an exception, was organized in the ſame manner.

Having arrived at this important diſcovery, I determined to proceed farther. I examined and tried the yellow duſt which ſurrounds the capſule, and I became convinced, from its inflammability, and from the difficulty with which it mixed with water, that it was of the ſame nature with the pollen of other vegetables. It now remained to prove that the ſmall oval body ſurrounded by the pollen is a true capſule, including the ſeeds. The obſervation, which I had formerly made with the microſcope, proved it, indeed, but not in a manner ſufficiently ſatisfactory, as there did not appear to be any direct communication between the pollen and the ſeeds, which are contained in the capſula. I had recourſe, again, to obſervation, and I fortunately caught nature, as it were, in the fact, and diſcovered the uſe and operation of each of the parts of which the urn of the moſſes is compoſed. As I was, one day, examining with attention the *Hypnum velutinum* of Linnæus, I endeavoured gently to take off the opercule with my fingers, which was very eaſily done, as the bloſſom was fully ripe. The opercule having fallen off, the cilia which detained it being thus free, and looſened from their former ſtate of tenſion, I was a witneſs to their curious manner of operating: they were in an almoſt continual convulſive agitation, and contraction, approaching to, and alternately receding from, the internal cilia, which ſeemed to me to open a little towards their extremity, at the ſame time that the others contracted themſelves by a contrary motion. I diſtinctly obſerved the pollen thrown out through the ſpace that opened between the internal cilia, near their baſis, as faſt as the external cilia fell back. Hence, it occurred to me, that the poſition and motion of theſe various organs are intended to reſtrain the impetuoſity of the pollen: and if we conſider how the pollen and ſeeds are diſpoſed, it will be eaſy to conceive that the former cannot come out without meeting the latter. Thus, nature, ever conſiſtent in her productions, has formed theſe cilia to moderate the convulſive emiſſion of the pollen, and to bring it into contact with the ſeeds before it eſcapes.

From the preceding obſervations, it follows, 1ſt. That theſe plants are endued by nature with the ſame organs of fructification as all others, to wit, a *flower.* (Fig. 3. 7. 14.).

2dly. That this flower has two eſſential parts, which ſeem to be the organs of generation, viz. a fecundating pollen, and a capſule containing the ſeeds (Fig. 15. 16. 18.).

3dly. That beſides the pollen and the ſeeds, there are other acceſſary parts, relative and proportioned to the conſtruction of that flower, and deſtined (Fig. 7. 14. 17.).

1ſt. To protect the ſexual parts when young, the cawl (fig. 4. 8.), the opercule (fig. 9. 14.), the cilia (fig. 17.).

2dly. To prevent the too rapid emiſſion of the pollen, that thus the buſineſs of generation may be the better accompliſhed, the internal cilia (Fig. 17. A.).

3dly. To diminiſh the effect of the impetuoſity of the ſame pollen, by checking its motion, and by detaining it for a moment at the orifice, when the fecundation is performed. This is done by the external cilia, by means of their irritability and oſcillatory motion (fig. 17. B.).

4thly. It appears that the urn is a bi-ſexual flower, containing a capſule more or leſs pedunculated, according to the length of the tube.

5thly. That the ſmalleſt moſſes, as well as all other vegetables, are reproduced by their own particular organs; that they obſerve the general law of all organized bodies, and that they furniſh an additional proof of the great axiom, *omne vivum ex ovo.*

With reſpect to that part denominated the *Star*, the writer admits, that the ſmall glandular parts, included under the foliola of the branches, certainly poſſeſs the faculty of reproduction; but he cannot allow that they are the only ſeed of the moſſes, and ſtill leſs the antheræ. Why may not there be, as in other vegetables, ſo in the moſſes, ſemiſexual flowers, either male or female? Why may not the *Polytrichum*, *Mnium*, and *Splanchnum*, be polygamous plants? We know alſo that the leaves of ſome plants, as of the *Lilium bulbiferum*, are furniſhed with ſmall bulbous glands which vegetate in the ground, though there is a perfect proceſs of fructification in the ſame plants. Why may not the ſtar of the moſſes be a ſimilar part? Whatever be its uſe, this will not affect the ſyſtem of an union of ſexes in the *urn*, in which, as in a true flower, ſeeds are fructified by the emiſſion of a pollen.

XXV. *A Letter from Major* JONATHAN HEART, *containing Obſervations on the Ancient Works of Art, the Native Inhabitants, &c. of the Weſtern Country.*

THE firſt article in this letter is *Ancient Works*, of which thoſe at the mouth of the Muſkingum have been deſcribed by this writer in the Columbian Magazine. The works at Grave-Creek are very ſimilar to theſe, and continue, at intervals, for ten or twelve miles on the banks of the Ohio. The Big-grave in the centre has been opened, and found to contain human bones. The works each way conſiſt of ſquare and circular redoubts, ditches, walls, and mounts, ſcattered over extenſive flats. The common mounts, or Indian graves, are ſcattered over the whole country, particularly about the Ohio, and occupy almoſt every high flat near a large ſtream.

Travellers have met with, on a branch of the Scioto, called Paint-Creek, works much more conſiderable than thoſe of Muſkingum or Grave-Creek, a much larger mount, a greater variety of walls, ditches, and encloſures, continuing for near ſixty miles along the Scioto, to its junction with the Ohio; oppoſite to which, on the Virginia ſide, are extenſive works. There are alſo works of note, ſimilar to thoſe of Muſkingum, on the Great Miami, about twenty miles from its junction with the Ohio, and alſo on the Little Miami, at the ſame diſtance from it.

A remarkable veſtige of antiquity has been reported to the author, by the Chactaw Indians, confirmed by ſeveral whites, to exiſt on the eaſt ſide of a ſmall branch of the Big-black, a river emptying into the Miſſiſſipi, in lat. 33. It conſiſts of an elevation of earth, about half a mile ſquare, fifteen or twenty feet high; from the north-weſt corner of which, a wall of equal height, with a deep ditch, extends for near half a mile to the high lands. The ſame perſons aſſert, that, on the low grounds of the Miſſiſſipi, which are very ſubject to be overflowed, at a place called Bio-Piere, is a very large mount, encompaſſed by a number of ſmaller ones, in a perfect circle, at equal diſtances from each other, and at about two hundred yards from the centre or grand mount. All that country is covered with veſtiges of ancient ſettlements.

Who thoſe inhabitants were, who have left ſuch traces; from whence they came, and where they are now, are queries, to which we never, perhaps, can find any other than conjectural anſwers. I can only give my opinion *negatively*, that they were not conſtructed by Ferdinando de Soto. He was not on the continent a ſufficient time to conſtruct even the works at Muſkingum; and, from every circumſtance, it appears, that he was no farther north than Chattafallai, a Chickaſaw-village, on the Tombigbee-branch of the Mobile. 2dly. Theſe works were not conſtructed by any European, Aſian, or African nation, ſince the diſcovery of America by Chriſtopher Columbus: the ſtate of the works, the trees growing on them, &c. point to a much earlier date. 3dly. They were not conſtructed by the preſent Indians, or their predeceſſors; or ſome traditions would have remained as to their uſes, and they would have retained ſome knowledge in conſtructing ſimilar works. 4thly. They were not conſtructed by a people who procured the neceſſaries of life by hunting: a number ſufficient to carry on ſuch works never could have ſubſiſted in that way. 5thly. I may venture to add, the people who conſtructed them were not altogether in a ſtate of uncivilization: they muſt have been under the ſubordination of law, a ſtrict and well governed police, or they could not have been kept together in ſuch numerous bodies, and made to contribute to the carrying on ſuch ſtupendous works.

As to *ſhells* and *petrifactions*, the writer mentions oyſter-ſhells of a monſtrous ſize, on the head waters of the Mobile, three hundred miles from the ſea. Foſſil ſhells are found in great plenty in all parts of the country, and petrifactions are frequent, eſpecially at the falls of the Ohio. Near the bottom of the falls is a ſmall rocky iſland, overflowed at high water, remarkable for being the ſeat of numerous petrifactions of various kinds, which are not found on the oppoſite ſhores. The *Big-bones*, found at Big-bone-Lick, are now in many cabinets. Many of theſe bones have been met with to the weſtward; and the Indians ſay, that the animal ſtill exiſts further weſt.

The *Natural Meadows*, or, as they are called, *Prairies*, cannot be accounted for. Some of them have doubtleſs emerged from the waters of the Miſſiſſipi, once, probably, an arm of the ſea. Others ſeem to have been drained lakes. But ſome are high lands, ſurrounded by a woody country, much lower than they are. There are proofs that the waters of the Miſſiſſipi, in paſt ages, flowed ſeventy feet higher than the preſent higheſt water-marks. On French-Broad-river, a branch of the Tenaſſee, are perpendicular rocks, on which, more than a hundred feet above the preſent high water, are artificial characters of beaſts, birds, &c. where it would be impoſſible to get at the ſpot, had not the river formerly flowed ſo much higher.

With reſpect to the *origin* of the inhabitants, the Chickaſaws ſay, that they came from where the ſun ſets in the water, and were ſeven years on their way, marching only one moon in a year, and encamping in the ſame place the reſt of the time. The ſimilarity of their language and that of the Chactaws proves a common origin. Thoſe of the different tribes of the Six Nations are alſo very ſimilar to each other; as are alſo thoſe of many of the Weſtern nations, and the Creek-nations or Muſcows. But theſe ſeveral claſſes of languages are totally different from each other.

With reſpect to the *cuſtoms*, and *manners*, and *arts* of the ancient inhabitants, this writer rather laments the want of accurate inquiries, than offers any thing new of his own knowledge. As to the *genius* of the Indians, he thinks it not inferior to that of any other nation; and their moral character, only that of *man* modified by particular circumſtances.

XXVI. *An*

XXVI. *An Account of ſome of the principal Dyes employed by the North American Indians.* *By Mr.* HUGH MARTIN.

THE *red* dye, uſed by the Indians, is a ſlender root called by them *Hau ta the caugh.* It is found to be madder, which grows naturally in their low ſwampy grounds. They pound the roots in a mortar, with the addition of crab-juice, and then throw the mixture into a kettle of water, along with the ſubſtance to be dyed. By this proceſs, they dye the white tails of deer, and porcupine quills, and can alſo give a beautiful red to wool.

Their *orange colour* is obtained from the root of the *Pocoon,* the outſide being pared off; and alſo from the plant called *Touch-me-not.* The colour is fixed by the ſame acid of crabs.

Their *bright yellow* is dyed with the root of a plant growing ſpontaneouſly in the weſtern woods. It is from one to three inches long, and half an inch in diameter, beſet with a number of filaments. The root ſends up a ſtalk about a foot high, at the top of which is one broad leaf. On the top of the leaf grows a red berry, in ſize and ſhape reſembling a raſpberry, but of a deeper red.

Their *green* is made by boiling various blue ſubſtances in the liquor of *Smooth-Hickery* bark, which dyes yellow. They dye their porcupine quills green by the water in which ſhreds of green cloth have been boiled.

Their *blues* are well known to be made by *Indigo.* It is to be obſerved that *Woad* is the natural produce of this country.

Black is dyed with *Sumach.* The Indians alſo make a beautiful black with the bark of the *White-Walnut,* and vegetable acid.

XXVII. *An Account of the beneficial Effects of the Caſſia Chamæcriſta, in recruiting worn-out Lands, and in enriching ſuch as are naturally poor: together with a botanical Deſcription of the Plant. By Dr.* JAMES GREENWAY, *of Dinwiddie-County, in Virginia.*

IN Maryland, and on the Eaſtern-Shore of Virginia, they have long been in the practice of ſowing a ſeed, which they call a *bean,* for the ſake of recruiting their worn-out lands, and enriching ſuch as are naturally poor. The beſt information, that I have, is, that they ſow a pint of the bean with every buſhel of oats. The oats ripen, and are cut in July, at a time when the young beans are ſmall, and eſcape the injury of the ſcythe. The beans flower in Auguſt and September. In October, the leaves fall off, the ſeeds ripen, and the pods open with ſuch elaſticity as to ſcatter the beans to ſome diſtance around. The year following, the field is cultivated with corn; the beans, which ſprout early, are all deſtroyed with the plough and hoe; but the more numerous part, not making their appearance above ground until the corn is laid by, ſpring up, unhurt by the inſtruments of agriculture, and furniſh ſeed for the enſuing year, when the field is again ſowed in oats. The ground is, alternately, cultivated with corn and oats, annually; and, in the courſe of eight or ten years, ſo greatly improved, that, without any other manure than the mouldered leaves and ſtalks of the beans falling on it, the produce will be three barrels* to the acre, on ſuch as, prior to this management, would not have produced more than one. This is ſaid to happen from the quick mouldering of the leaves and ſtalks of the bean-plant, and its aptitude to mingle and unite with the earth, without undergoing a fermentation. Thus, the ſoil is yearly and gradually enriched by this ſimple and eaſy proceſs of nature, without the labour and expence of accumulating animal and vegetable matters, to undergo the tedious operation of fermentation and putrefaction; by which the diſſolution of thoſe ſubſtances is brought about, and fitted for manure, in the uſual way. Notwithſtanding this extraordinary character of the Eaſtern-Shore-bean, I am clearly of opinion, that our common corn-field-pea is far preferable to every thing that I have ſeen tried for this purpoſe. Every farmer, who leaves his pea-vines on the ground, and does not, in the accuſtomed manner, pull them up for fodder, muſt often have obſerved, that they quickly moulder and fall to pieces; furniſhing a covering to the ground, which readily unites and blends with it, in the manner mentioned of the bean. If a piece of exhauſted land, ſufficiently level to prevent its waſhing away with the rain, be annually cultivated in peaſe, leaving the ſtalks and leaves to moulder and crumble to pieces upon it, the ground will improve beyond expectation; the crop of peaſe increaſing, every year, and the ſoil becoming richer and richer, without any other manure. I was told, by an eminent planter, that poor ground might, by this management alone, be made rich enough to produce good tobacco.

The Eaſtern Shore-bean, ſo called from its being firſt cultivated there, is found in all parts of Virginia and Carolina, upon all ſorts of lands, except too wet. It has by ſome been miſtaken for the common tare, or partridge pea, to which it bears ſome reſemblance, but it belongs to a different claſs of plants. The following is an exact deſcription of it, adapted both to the botaniſt and farmer.

Caſſia Chamæcriſta Linnæi. Decandria Monogynia.

Radix annua fibroſa. Caulis ſeſquipedalis, erectus, teres, lævis, ramoſus, coloratus. Folia alterna, pinnata, multijuga, abrupta; foliolis oppoſitis, ovalibus, glaberrimis, æqualibus, cum forma et ſenſibilitate Mimoſæ; foliis ſimillimis. Flores ſparſi, pedunculati, ſpecioſo aureo colore, antheris purpureis. Stipulæ binæ laterales, erectæ, lanceolatæ, acutæ. Glandula ſuper medium petioli, in plantis majoribus, pedicellata. Pedunculus ſpatio ſupra petiolum egreditur. Ab menſe Auguſti ad finem æſtatis floret; ſolis omnibus habitat, ſed humili maxime gaudet. The Golden-Caſſia, or Peacock-Flower, is an annual plant, the root and ſtalk dying every year. The root is ſmall, conſiſting of fibres, or threads. The ſtem is upright; in ſmall plants, not more than eight inches high; but in richer ground, where level and moiſt, the ſtem riſes to a foot and a half, or two feet; a little crooked, round, ſmooth, and coloured; branching out at the upper part, and bearing many flowers, ſtanding on bending footſtalks, ſcattered all over the main ſtem and branches. The petals, or flower-leaves, are five, of a fine golden colour, with ten male ſtamina, or threads, in the middle, crowned with antheræ, or buttons, of a red or purple colour. Theſe filaments, ſomewhat reſembling the creſt or plumage on the head of a peacock, have led ſome botaniſts to name it criſta pavonis, or peacock flower; but the plant, we here treat of, being a ſmaller ſpecies, they have added Chamæcriſta pavonis, or Dwarf-Peacock-Flower.

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* A barrel is a meaſure of five buſhels, much uſed in Virginia.

In the middle of the ten male filaments above-mentioned, will be readily obſerved another ſingle thread or ſtyle, which is the female part of the flower, producing the ſeed-veſſel, or bean; each pod containing a ſingle row of black ſhining ſeeds, fixed to the upper ſuture, or back-ſeam of the bean: theſe ſeeds are nearly flat, four-cornered, and not in the leaſt reſembling a bean or pea. The partridge-pea may be eaſily diſtinguiſhed from this, by colour and ſhape: the latter is brown, and kidney-ſhaped. The leaves are pinnated or winged (viz. like the Locuſt, Senna, Partridge-pea, &c.), grow alternately from the ſtem, on a ſlender foot-ſtalk, which has a ſmall gland or wart, placed upon the middle of every one; and theſe glands, upon the larger plants, are elevated on a pedicle, or ſhort ſtalk, conſpicuous to the naked eye. At the baſe of every foot-ſtalk, upon the ſtem, are found two very ſmall upright ſpear-pointed leaves called ſtipulæ, which, by the help of a glaſs, appear to be hairy. The ſmall leaves are placed oppoſitely on the midrib, to the number of twenty pair, or more; oval-ſhaped, ſmooth, ending in an even number, in ſhape and ſenſibility reſembling the leaves of the mimoſa, or ſenſitive plant. They ſhut up at night and expand in the morning, until, through age, they loſe this ſenſibility. Frequent ſhaking or ſtriking with the hand will cauſe them to ſhut up; and in like manner, when gathered, they cannot be carried far before they collapſe; ſo that, if the botaniſt wants to preſerve the leaves expanded, in *horto ſicco*, he muſt incloſe the plant when gathered on the ſpot, with as gentle a motion as poſſible.

The month of October being the ſeaſon for gathering the ſeed, the leaves then falling off, the farmer will readily find the plant, upon all ſorts of ground, amongſt the weeds, and even in Broomſtraw old fields; and will eaſily diſtinguiſh it, by the brown colour of the pods, and the redneſs of the ſtalks. Let it be pulled up by the roots, dried on a cloth in the ſun, and then threſhed out with a ſtick, and preſerved in a bag, hung up in a dry place, until the ſeaſon for ſowing it with oats.

XXVIII. *An Account of a Hill on the Borders of North Carolina, ſuppoſed to have been a Volcano.*

THIS hill, called by the people the *Burſted-Hill*, is on the Dan-river. Its baſe is about three quarters of a mile in circumference. Its form is conical, one hundred and thirty feet high. The crater is nearly filled up, and covered with large trees, but one ſide has ſtill a hollow appearance. The hill appears to be formed of lava mixed with round white ſtones, that eaſily break. There are large maſſes of the melted matter, weighing a thouſand pounds or more, on the ſummit of the hill, where the lava is ſuppoſed to have burſt out, and alſo at different diſtances round. The lava ran for near half a mile, and ſtopped within twenty yards of a creek. Its ſtream is nearly uniform in thickneſs, and appears to have been ſix or eight inches deep, but is now crumbled to pieces. A mould of rich earth is formed upon it, five or ſix inches thick, of the ſame nature as that on the adjacent ground, and probably depoſited by inundations.

inundations of the river. The mouldered lava is of the colour of ruſty iron. When pulveriſed, it is attracted by the magnet. The lava melts in a crucible to a confuſed liquid maſs. There are a number of round ſtones thrown to the diſtance of half a mile from the hill, which ſeem to have felt the force of fire to a conſiderable degree.

XXIX. *An Account of a poiſonous Plant growing ſpontaneouſly in the Southern Part of Virginia. By Dr.* JAMES GREENWAY.

THIS plant, which is of the umbelliferous tribe, bears in the country the names of wild-carrot, wild-parſnep, fever-root, and mock-eel-root. It moſt reſembles Angelica. Its deſcription in Latin and Engliſh is thus given:

Cicuta Venenoſa. Claſſis, Pentandria. Ordo, Digynia.

Radix perennis, fuſiformis, perpendicularis; colore et odore paſtinacæ radicis prædita. Caulis erectus, herbaceus, quatuor pedes altus, teres, fiſtuloſus, geniculatus, ſubnudus, ſtriato-canaliculatus, purpureus, ſupernè tomentoſus.—Folia petiolata, petiolis ſemi-amplexicaulibus, membranaceis, ſulcatis, triternata, bipinnata, cum impari terminatrice, ſæpe bilobo; foliolis ſeſſilibus, oblongo-lanceolatis, ſerratis.—Folia ima longiſſimè petiolata, triternata, foliolis ovalibus ſerratis, ſerraturis denticulatis.

Flores albi, in umbellis compoſitis ſubrotundis, ſine involucro univerſali cum partiali polyphyllo. Locis campeſtribus et collibus apricis gaudet: menſibus Julii Auguſtique floret.

Hemlock, Poiſonous Mock-Eel-Root, &c.

The root is perennial; of the colour and ſmell of a parſnep, but much ſmaller. The ſtalk riſes four feet high, upright, round, lightly channelled, as if fluted; of a purple colour, hairy or downy on the upper part; hollow and jointed. There are only two, three, or four pair of leaves, placed oppoſitely, at the joints, on membranaceous hollowed ſtalks, which embrace the main ſtem. The leaves are winged, terminated with an odd one, which is frequently divided into two lobes.

The folioles are oblong, and ſpear-ſhaped, ſawed on their edges. The flowers are white, compoſing a large compound umbel, without any involucrum; containing many ſmaller or partial umbels, each with an involucrum of many ſmall narrow leaves. The filaments and ſtyles may be ſeen projecting beyond the flower leaves, being longer than the petals are. It grows on hilly barren lands, on dry grounds and open fields; though ſometimes I have found it in moiſt places. It blooms in July and Auguſt.

Its effect on the human body is diſplayed in the following relation:

Some time in the month of May laſt, three negro-boys were ſearching in the woods for wild angelica, or, as they commonly call it, eel-root. They found a plant, and dug up the root, but upon taſting it, the two elder of the boys perceived it was not the root they wanted. They therefore threw it down, and left it. The youngeſt boy took it up, ſaid it was eel-root, and he would eat ſome of it. They went on ſearching and digging for ſome time: at length their young companion was miſſing; they turned back the way they came, and found him lying on the ground, ſpeechleſs and ſenſeleſs. They took him up, to carry him home: a neighbour met them on the way, to whom the boys related the ſtory, as above. This gentleman, upon whoſe veracity I relate this fact, being a man of reputation and character,

racter, and in whoſe integrity I place the greateſt confidence, told me the ſtory, a few days after it happened. He ſays, he ordered the boy to be laid down, under a tree; poured down ſome milk and oil, and ſent him home to his owner, who lives within a mile. He was utterly deprived of ſenſe; there was no convulſion, or ſpaſm; nor any degree of tenſion, or ſtiffneſs: his limbs were perfectly limber and looſe; he appeared to be in a deep ſleep, deprived of all motion, except that of reſpiration. The boys ſhewed this gentleman the plant, that the diſeaſed one had eaten of. Some of the leaves were ſhewn to me, which I immediately diſcovered to be the ſpecies of hemlock, here mentioned. The boy was carried home; and, after a day or two, came to his ſenſes again; but they think he has never perfectly recovered: a ſmall degree of dullneſs and ſtupidity ſtill remains on his brain.

XXX. *Deſcription of a Machine for meaſuring a Ship's Way. By* FRANCIS HOPKINSON, *Eſq.*

CLOSE along the ſhip's bow, is a copper pipe, about two inches in diameter, extending downward as low as the keel, and upward above the water-line when the veſſel is loaded. This pipe muſt be ſo bent at the bottom as that its orifice may be directly oppoſed to the line of the ſhip's progreſs, and project but a little way beyond the keel or cut-water. The upper part of this pipe muſt alſo be ſo bent as that it may enter into the fore-caſtle, through a hole made for the purpoſe, above the water-line. The pipe ſhould be ſecured in its place by ſtaples or clamps.

On the top of this copper pipe ſhould be a cover to be ſcrewed on, and through the cover a hole muſt be made for the admiſſion of a glaſs tube, of the ſize of a common barometer tube, and cemented there. The ſea water will riſe in the copper pipe to the general level of the ſea, but will not appear in the glaſs tube becauſe the copper pipe enters the ſhip above the water line, as before obſerved. But if a quantity of oil be poured down the glaſs tube, the ſurface of the oil will riſe and become viſible in the tube, on account of the ſpecific difference between oil and ſea water.

This glaſs tube muſt alſo be furniſhed with a ſcale for meaſuring the different heights of the oil, the cypher, or (o) of the ſcale being on a line with the ſurface of the oil when the ſhip is at reſt, or makes no way. But when ſhe is in a progreſſive motion, the water contained in the copper tube, together with the column of oil in the glaſs tube, will be forced upward, in proportion to the velocity with which the veſſel proceeds; which will be aſcertained by the different altitudes of the ſurface of oil, viſible on the graduated ſcale.

The glaſs tube ſhould be made to run ſome depth into the copper pipe, and alſo be of a ſufficient height above, to allow room for the vibrations of the column of oil, when the ſhip is agitated by the waves.

When the ſhip has got every thing on board, and whilſt ſhe is under no way, the ſurface of the oil muſt be regulated by bringing it even with the (o) or cypher of the ſcale; and this examination ſhould be frequently made on account of the conſumption of proviſions, and other waſte, that may alter the ſhip's draught of water.

In taking down the reckoning from the ſcale, the moſt favourable moment ſhould be watched for a fair obſervation, viz. when the ſhip is proceeding with an average velocity, not when ſhe is in the act of plunging into, or riſing above the level of the waves, as this would ſenſibly affect the truth of the ſcale. But a little experience would ſoon make the uſe of the inſtrument familiar.

XXXI. *An Inquiry into the Queſtion, whether the Apis Mellifica, or true Honey-Bee, is a Native of America.* By BENJAMIN SMITH BARTON, *M. D.*

THE lately-prevailing opinion that the true honey-bee is not a native of America, but has been imported from Europe, has been controverted by the Reverend Dr. Belknap, in a diſſertation on the ſubject, to which this is meant as an anſwer.

Mr. Jefferſon, in his *Notes on Virginia*, ſeems to have given riſe to the inquiry. He aſſerts, that the honey-bee is not a native of the American continent; and that the Indians concur with the whites in the tradition, that it was brought from Europe, calling it the *white man's fly*, and conſidering its approach as indicating that of white ſettlers. Dr. Belknap, who admits theſe facts, does not, however, allow the concluſion. His firſt argument, that this bee is a native of America, is taken from the hiſtory of Columbus, who is ſaid to have written the account of his diſcovery on a roll of parchment, and committed it to the ſea, encloſed in a cake of wax, which he procured in Hiſpaniola. Our writer obſerves upon this, that there is no doubt that various ſpecies of bees exiſted originally in America, many of which, as well as waſps, form honey and wax; and that Columbus uſed, might be the product of one of theſe, but not of the true honey-bee. His wax might alſo have been collected from ſome plants which are known to yield it, as the *Myrica cerifera.*

The ſecond argument is, that Purchas giving an account of the revenues of the Mexican empire before the arrival of the Spaniards, as recorded in pictures on cloth, mentions the figures of pots ſaid to contain honey. The Abbé Clavigero, in his late hiſtory of Mexico, confirms this account, and mentions, among other articles of revenue, 600 cups of honey annually paid by the inhabitants of the ſouthern parts of the empire. He alſo ſays, that there are now in Mexico ſix ſpecies of honey-making bees, four without, and two with ſtings, one of the latter agreeing in all circumſtances with the common bee of Europe. But in anſwer to theſe objections it may be replied, that the tribute-honey of the Mexicans might be procured from ſome other ſpecies of bee; and that if there is the true honey-bee at preſent in Mexico, it is no proof that it exiſted there 2 or 300 years ago. Acoſta, the jeſuit, who wrote in 1590, mentions bees in America, which make their combs in trees, or under ground, and which are ſmall, like flies, and yield a ſharp and black honey.

Lionel Wafer notices bees among the productions of the Iſthmus of Darien, but without identifying the ſpecies. It is evident, that ſome of them were without ſtings.

A fact related by Purchas, that Ferdinand de Soto, in his expedition to Florida, in 1540, found a ſingle pot of honey, has been produced as an argument for the exiſtence of the honey-bee there. But the ſame anſwer may be made to it, as that concerning the Mexican honey; and the diſcovery of this ſingle pot amidſt a variety of proviſions of the natives, is rather a proof againſt their poſſeſſing the honey-bee; eſpecially as a Portugueſe account of the expedition ſays expreſsly, that they met with neither honey nor bees, before nor after, in all Florida. Further, Mr. Bartram informed the preſent writer, that, in 1775, he was ſhewn in Weſt Florida a ſingle bee-hive, the only one in the country, brought from England in 1763. He ſays, indeed, that in Eaſt Florida the honey-bee is found wild, but he believes it not native there. Mr. Page du Pratz ſays, that the bees of Louiſiana chiefly lodge their honey in the earth. But theſe inſects are known not to be real bees, but more allied to the waſp tribe.

Dr. Belknap has endeavoured to do away the argument of the European origin of the honey-bee, drawn from its Indian name of *the white man's fly*, by obſerving, that from the repaſt they derive from the bloſſoms of fruit trees, and the flowers of clover and buck wheat, they would naturally haunt the neighbourhood of the ſettlements of the whites, which might cauſe the Indians to give them the above appellation. But the fact is, that the Indians, who are not incurious obſervers of nature, mean by it to convey the idea of the bee being imported by the Europeans; in the ſame manner as they call the *Greater Plantain* by a name ſignifying the *Engliſhman's foot*, and ſay, that wherever an European has walked, this plant grows in his footſteps; thereby denoting in their figurative language, that it was not known before their arrival in the country.

That the honey-bee is not a native of the northern parts of America, may be proved both by negative and poſitive evidence.

1. Lawſon does not mention it among the animals of Carolina. William Penn, in a long letter diſplaying the advantages of his new ſettlement of Pennſylvania, takes no notice of bees. The writers of Virginia never mention them as native animals. No words for honey or wax are found in many of the Indian languages. The Delawars, indeed, call bees by the ſame name as waſps, which are natives. The Mohegans have names for honey and wax, but they are ſuch as would naturally be formed for newly introduced ſubſtances; thus that for honey is a compound ſignifying *ſweet or ſugar of bee*; and that for wax, *greaſe, fat,* or *tallow of bee.*

2. For poſitive evidences, may be adduced that of Mr. John Joſſelyn, who was in New England in 1638 and 1663, and ſays, that "the honey-bees are carried over by the Engliſh, and thrive there exceedingly." Dr. Belknap ſays, that there is a tradition in New England, that the firſt perſon who brought over a hive of bees, was rewarded by a grant of land. Theſe circumſtances prove, at leaſt, that the honey-bee *was not known* to be a native. The Rev. Mr. Heckewelder has informed the author, that though he has ſeen the honey-bees wild in various parts of North America at ſome diſtance from white ſettlements, yet the Indians always affirmed, that they were not known till the whites began to ſettle among them. This bee was not known in Kentuckey when that country was firſt diſcovered; but a hive being introduced in 1780, they have ſince ſo prodigiouſly increaſed, that a hunter has found 30 wild ſwarms in one day. They were not known in that part of New-York called the Jeneſſie-country when it was firſt viſited, nor for a conſiderable time after. It is obſervable, that when hives are firſt introduced, ſome of the bees turn deſerters, and roam into the woods, where they ſettle in the hollows of trees. Theſe deſerters ſeem peculiarly diſpoſed to follow the courſes of creeks and rivers, where are rich grounds, called *bottoms,* abounding in various plants agreeable to bees, ſuch as the *Polygonum ſcandens,* or *Wild Buckwheat,* &c.

XXXII. *An Account of a Comet. Read Feb.* 15, 1793.

DEAR SIR,

ON the 11th of January laſt, in the evening, I diſcovered a comet in the conſtellation Cepheus. That night and the following it appeared, to the naked eye, ſuperior in brightneſs to a ſtar of the ſecond magnitude. On the 13th, it was evidently diminiſhed, and it continued to grow more faint until about a week ago, when it diſappeared. It paſſed very rapidly through Caſſiopeia, Andromeda, the Triangle and Aries. January the 17th it was near the firſt ſtar of Aries, and on the 31ſt very near Flamſteed's 84th ſtar of the Whale; and a little further ſouth I ſaw it, for the laſt time, on the evening of the 8th of February.

Dear Sir,
Yours, &c.
DAVID RITTENHOUSE.

To Robert Patterſon, Secretary to
the Philoſophical Society.

XXXIII. *Cadmus, or a Treatiſe on the Elements of Written Language, illuſtrating, by a Philoſophical Diviſion of Speech, the Power of each Character, thereby mutually fixing the Orthography and Orthoepy; a Prize Diſſertation. By* WILLIAM THORNTON.

THIS writer laments, with many others, that there ſhould be ſo great difficulty in learning the pronunciation of a foreign language by written characters, or writing correctly one's own language, from the radical defects in the alphabet of every nation. To correct this, and to make an univerſal alphabet, there ought to be a mark for every ſound which the voice can utter, and only one mark for each ſound. As a clear proof that an invention of this ſort is much wanted, we need only put into the hands of men of different nations any book written in the Roman character, to which they have been all accuſtomed from their infancy, and each one will read it in a manner unintelligible to the others; and if it ſhould be urged, that the old orthography is to be retained to prevent obſcurity in writing, we may anſwer, that if words of different import were ſpelt in the ſame manner, they would not be leſs miſunderſtood than words of the ſame ſound in converſation. Thus bear, to carry; bear, a beaſt; and bare, naked, are not miſtaken in converſation, nor would they be ſo, if ſpelt in the ſame manner in writing. If the preſervation of derivatives is conſidered of ſuch great importance, that a wrong orthography muſt be retained, let it be remembered, that the derivation of even the commoneſt monoſyllables was ſcarce known, till John Horne Tooke detected the learned abſurdities of Harris, Johnſon, Lord Monboddo, and other writers of the ſame ſchool.

Some of the moſt learned men are men of the leaſt knowledge—take away their ſchool learning, and they remain children. As all their conſequence in life conſiſts in their acquaintance with dead languages, they, no doubt, would condemn any attempt to leſſen the dignity of ſuch acquirements. ‘ You muſt not alter the orthography of languages, becauſe we cannot afterward derive the words, then all the learning we have taken ſo much pains to acquire will be uſeleſs.'—We muſt thus preſerve bad ſpelling to render dead languages uſeful in its derivation, and we muſt learn dead languages to derive bad ſpelling—! When does the lady (who ſpeaks the moſt elegant language) aſk the pedant whence the words are derived! He has ſpent two minutes in two languages to know the meaning of the word, and ſhe has ſpent two minutes in one language; and where is the difference? A child muſt ſpend many years in learning dead languages, that he may know more perfectly his own. Few acquire more than one language with its elegancies. I have known good Latin ſcholars, in England, incapable of writing Engliſh tolerably.—! How much more rational would it be, to ſtudy the Engliſh twice as long, than to ſtudy another language to obtain the Engliſh! There is ſcarcely one man in fifty, even among the learned, that writes every word with what is, *moſt erroneouſly*, called a correct orthography, without a lexicon, among the unlearned none, and few among well educated ladies. Theſe difficulties depend greatly upon falſe ſpelling, becauſe they all pronounce much more alike than they write; and that falſe ſpelling, in its origin, depended as much upon a want of knowing the alphabet, as upon the change of language for the ſake of euphony. People are more aſhamed of expoſing bad orthography than bad writing: the only difference, however, between what the world calls bad ſpelling and good, is, that the firſt contains the blunders of the writer only, the latter contains the blunders of every body elſe.

The advantages attending a proper orthography are theſe: 1ſt. Travellers might give perfect vocabularies of the language they hear. 2. Foreigners might learn a language in their cloſets. 3. Dialects would be utterly deſtroyed. 4. Every one would write with a perfectly correct orthography. 5. Children might learn to read with very little trouble in a ſhort time, having only to acquire about thirty letters. The fault is, that the names of the letters, inſtead of the powers, are invariably ſtudied: we conceive them not to be ſimple ſounds, and hence the ridiculous diviſion of the alphabet into vowels, conſonants, mutes pure and impure, ſemivowels, and their numerous ſubdiviſions.

The characters ought to be divided into two claſſes, vowels and aſpirates. A vowel is a letter ſounded by the voice, an aſpirate by the breath. In the Engliſh language there are twenty-one vowels, and nine aſpirates. For theſe, particular marks are recommended, and the alphabet ſtands thus: e, pronounced as in herd; a, law; a, rat; e, red; i, fit; o, fog; o, fool; y, ye; z, zeal; r, red; l, let; g, judge; v, vaſt; th, that; w, wolf; m, met; n, nap; ng, king; g, get; b, bat; d, dim; ſh, ſhip; f, fit; th, thin; ſ, ſet: k, kiſs; p, pen; t, ten; wh, when; h, hat.

To learn this alphabet, children are to be taught the true pronunciation of each letter by certain rules, ſhewing them in what manner the ſound is to be made. The firſt letter, according to the firſt rule, is made by opening the mouth a very little, juſt ſufficient to ſhew the edges of the upper teeth, producing a vocal ſound low down in the throat, and ſuffering the tongue and lips to remain at reſt, the epiglottis only being raiſed by the breath, which, by a contraction of the glottis by the ſurrounding muſcles, occaſions a tremulous motion and ſound called voice, that can be felt by applying the fingers to the throat; but this tremulous motion can only be felt when vocals are ſounded, ſo that thoſe, who are born deaf, may be made ſenſible of the difference by feeling only, and can thus diſcover, when they are learning the elements of ſpeech, whether or not they pronounce properly.

If it were poſſible to eſtabliſh theſe rules, and of the ſame nature are the ſubſequent ones, the tongue and pen would expreſs every idea with perfect uniformity.

The language of man was formed by imitating the objects of nature. Animals have a variety of ſounds more than ſufficient, if they could all be imitated, for every uſeful purpoſe; and as it is, there are few languages without ſuperfluous characters. Thus in the Engliſh are c, q, and x, and a moſt copious language may be formed with an alphabet not very extenſive.

When the alphabet is formed on true principles, the diſtinction of a word into ſyllables will be made without any difficulty, and we ſhould ſee at once the impropriety of Sheridan's obſervation, that the termination ble, is not in ſtrict propriety a ſyllable. Accents would alſo be avoided; as the noun *cement* would be diſtinguiſhed from the verb *cement*, merely by the writing, and ſo of others. Digraphs and diphthongs, which cannot exiſt in any language, would evidently be excluded upon this new plan; and it is properly obſerved here, that a language is now almoſt as eaſily learnt as the rules by which it is formed. Many improvements might be made in the ſtops; as, beſides thoſe now in uſe, a mark for irony, and the depreſſion of the voice, like the *aſide* in plays, might be introduced. From the introduction of ſuch an alphabet, with the concomitant improvements, the time and labour of the riſing generation would be ſpared, and their early years, inſtead of being waſted in tireſome rules to fatigue and deaden the mind, would be employed in a ſuitable manner; ſo that every one, on entering into the world, would be capable of ſpeaking his language with propriety, and even dignity.

Beſides the general advantage attendant on a new arrangement of the alphabet, the deaf and dumb may be taught by this mode to communicate their ideas with facility to each other. If the dumbneſs is occaſioned merely by the want of hearing (for if it ariſes from a malconformation of the organs, it is in vain to proceed), let a child be told to pronounce the letters which you wiſh the deaf child to learn, and by imitating the motions of the former, the latter may be led to pronounce them. Shew the deaf perſon alſo the ſituation of your tongue, as nearly as you can in ſpeaking, and diſpoſe your lips ſo as to give the ſound, making apparently a more forcible exertion than common. The pupil imitating it will make a ſound either vocal or aſpirate, and if it is to be found in the language, point out the character by which it is repreſented, and after ſome practice the ſymbol and the ſound will be aſſociated together. Let him alſo, if the ſound be vocal, feel at your throat and his own, and let him feel how your tongue is raiſed to the roof of your mouth, puſhed forward, depreſſed, withdrawn, &c. and have a looking-glaſs always preſent to ſhew him in what he errs. Having learned the thirty letters in the Engliſh language, the pupil ought to have a catalogue of objects repreſented, that he may affix proper ideas to proper terms, and a book, in which ſhould be written under proper heads the names of familiar objects, and under them thoſe things which have a connection, beginning with genera, and deſcending to ſpecies.

XXXIV.

XXXIV. *Obſervations on the Theory of Water Mills (continued).* By W. WARING.

IN the preceding paper (No. XXII.) on this ſubject, it is demonſtrated, that "the force of an invariable ſtream impinging againſt a mill-wheel in motion, is in the ſimple direct ratio of the relative velocity;" but leſt, on finding the effect to be as the ſquare of the velocity, it ſhould be concluded that the theory is ill founded, the following obſervations may be added. The greateſt effect of an underſhot wheel by a given quantity of water, in a given time, is in the duplicate ratio of the velocity of the water. For the impetus on the wheel is as the relative velocity, and the velocity of the wheel producing a maximum, being half that of the water, is as the velocity of the water; therefore this impetus multiplied into the wheel's velocity, or the effect produced, muſt be in the duplicate ratio of the velocity. If the force on the wheel were in the duplicate ratio of the water's velocity, as uſually aſſerted, then its effect on the preceding ſuppoſition would be as its cube, which is contrary to experiment.

The following proof may be given of the equivalence of Dr. Barker's mill to the underſhot mill. They are equal, becauſe the underſhot mill is propelled by the action, and the rotatory tube by the re-action of the ſame agent or momentum. The acting and counteracting forces originating within the tube, not being from any external impulſe, can be no exception, ſince the mutual actions and re-actions of the parts of any ſyſtem on each other do not alter the motion of their common centre of gravity. Hence the increaſe of power from the centrifugal force, multiplied into the augmentation of velocity occaſioned by it, is juſt equal to the force neceſſary to move the water into its ſpiral direction.

XXXV. *An Improvement on Metallic Conductors or Lightning-rods, in a Letter to Dr.* DAVID RITTENHOUSE, *Preſident of the Society, from* ROBERT PATTERSON *of Philadelphia.*

⁂ *This Paper was honoured with the Magellanic Premium, by an Award of the Society, in December* 1792.

SIR,

FROM the inſtances which now and then occur of houſes being ſtruck with lightning, that are furniſhed with metallic conductors, and the frequent inſtances of theſe conductors having their tops melted off by a ſtroke of lightning, it appears that this admirable contrivance for guarding houſes againſt the dangerous effects of lightning, is, in ſome degree, ſtill imperfect. Some improvement ſeems yet to be wanting at both extremities of the rod—at the upper extremity, to ſecure it againſt the accident of being melted, which renders it afterwards unfit to anſwer its original intention, viz. drawing off the electric fluid, or lightning, from the paſſing cloud, in a ſilent, imperceptible manner; for it is only *pointed* conductors that poſſeſs this property—and at the lower extremity, to afford a more ready paſſage for the fluid into the ſurrounding earth.

The firſt of theſe intentions would, I am perſuaded, be effectually anſwered, by inſerting in the top of the rod a piece of *black-lead*, of about two inches long, taken out of a good pencil, and terminating in a fine point, projecting but a very little above the end of its metallic ſocket; ſo that, if the black-lead point ſhould happen to be broken off by any accident, of which, however, I think there can be but little danger, ſtill the point of the rod would be left ſharp enough to anſwer the purpoſe of a metallic conductor.

This ſubſtance is well known to be infuſible, by the greateſt heat, and hence its uſe in making crucibles; nor is it evaporable, as remarked by Cronſtedt, in his Mineralogy ſect. 231, except in a ſlow calcining heat, to which it could never be expoſed on the top of a lightning-rod.

At the ſame time its power as a conductor of electricity is perhaps equal, or but little inferior, to that of any of the metals. A line drawn on a piece of paper by a black-lead pencil will, as I have often experienced, conduct an electric exploſion ſeemingly as well as a ſimilar line of gilding would do, and that without ever loſing its conducting power, which is not the caſe with gilding.

The ſecond intention is, to facilitate the eſcape of the electric fluid from the lower part of the rod into the ſurrounding earth. It is, in many caſes, impracticable, from the interruption of rocks or other obſtacles, to ſink the rod ſo deep as to reach moiſt earth, or any other ſubſtance which is a tolerably good conductor of electricity. Nor even if this were practicable, would it, I preſume, be alone ſufficient to anſwer the deſired intention. Iron, buried in the earth, and eſpecially in moiſt earth, will preſently contract a coat of ruſt, which will continually increaſe till the whole is converted into ruſt: but ruſt of iron, and indeed the calx of all metals, is a *non-conductor*, or at moſt but a very imperfect conductor of the electric fluid. Hence it is eaſy to ſee, that, in a few years after a lightning rod has been erected, that part of it which is under ground will contribute little or nothing to the ſafety of the building. Beſides, the ſurface of this part of the rod is *too ſmall* to afford an eaſy and copious diſcharge of the electric fluid into the ſurrounding earth, when this is but an imperfect conductor.

As a remedy for theſe defects, I would propoſe, that the part of the rod under ground be made of tin, or copper, which are far leſs liable to corroſion or ruſt, by lying under ground, than iron. Or, which perhaps would anſwer the purpoſe better, let this part of the rod, of whatever metal it be made, be coated over with a thick cruſt of black-lead, previouſly formed into the conſiſtence of paſte, by being pulveriſed and mixed with melted ſulphur (as in the manufactory of the ordinary kinds of black-lead pencils), and then applied to the rod while hot. By this means, the lower part of the rod would, I apprehend, retain its conducting powers for ages, without any diminution.

In order to increaſe the ſurface of the lower part of the conductor, let a hole or pit, of ſufficient extent, be dug as deep as convenient; and into this pit let there be put a quantity of *charcoal*, round the lower extremity of the rod. Charcoal poſſeſſes two properties, which, in a peculiar manner, fit it for anſwering the purpoſe here in view. (1) It is a very good conductor of electricity, and (2) it will undergo little or no change of property by lying ever ſo long in the earth. Thus might the ſurface of

that

that part of the conductor in contact with the earth be increaſed, with little trouble or expence, to any extent at pleaſure ; a circumſtance which every one acquainted with electrical experiments, muſt acknowledge to be of great importance to the end here propoſed.

XXXVI. *An eaſy and expeditious Method of diſſipating the noxious Vapour commonly found in Wells and other Subterraneous Places, by* EBENEZER ROBINSON, *of Philadelphia.*

AFTER various unſucceſsful trials (a detail of which has been already communicated), I was led to conſider how I could convey a large quantity of freſh air from the top to the bottom of the well ; ſuppoſing that the foul would neceſſarily give way to the pure air.—With this view I procured a pair of ſmiths bellows, fixed in a wooden frame, ſo as to work in the ſame manner as at the forge. This apparatus being placed at the edge of the well ; one end of a leathern tube (the hoſe of a fire engine) was cloſely adapted to the noſe of the bellows, and the other end was thrown into the well, reaching within one foot of the bottom. At this time the well was ſo infected, that a candle would not burn at a ſhort diſtance from the top ; but after blowing with my bellows only half an hour, the candle burned bright at the bottom; then, without further difficulty, I proceeded in the work, and finiſhed my well.

Wells are often made in a very ſlight manner, owing to the difficulty of working in them, and there have been ſeveral fatal inſtances of the danger attending the workmen ; but by the above method, there is neither difficulty nor danger in completing the work, with the utmoſt ſolidity.

It is obvious, that in cleanſing vaults, and working in any other ſubterraneous place, ſubject to damps, as they are called, the ſame method muſt be attended with the ſame beneficial effect.

XXXVII. *A Method of draining Ponds in level Grounds. By* JESSE HIGGINS, *of Delaware.*

AT a certain diſtance below the ſurface of the earth, there is a ſtratum of looſe ſand, which freely admits the paſſage of water. This ſtratum is at various depths, in different elevations ; but it will be generally found, that lands moſt ſubject to ſtagnant ponds, have but a ſhallow ſtratum of clay, over the ſand.

All that is neceſſary, therefore, is to dig a pit in the bottom of the pond, till you arrive at this ſtratum of ſand, when the water will be immediately abſorbed, and the pond emptied. Should there be too much water to permit a hole to be dug within the pond, it may be made at the edge of it, the communication afterwards made by a trench. It would be prudent not to make the ſides of the pit ſo ſteep, as to prevent cattle from getting out, ſhould they happen to go in.

The writer does not pretend to be the original author of this invention ; the idea was ſuggeſted to him, by ſeeing it practiſed by a farmer, who enjoyed the benefit, though he did not appear to know the cauſe.

XXXVIII. *Obſervations on the Severity of the Winter* 1779, 1780, *by the Reverend* MATHEW WILSON, *of Lewis, dated 22d of June* 1780.

THE extreme cold made great devaſtations on the animal and vegetable kingdoms. Such obſervations as were in my power to make, are,

1. The moles generally periſhed, many were found dead above ground.

2. The bees are almoſt all deſtroyed; but few hives have eſcaped.

3. The frogs ſuffered greatly; it is ſuppoſed that at leaſt two thirds of the ſpecies were cut off.

4. Our ſhell fiſh of all kinds, that run in ſhoal waters, were deſtroyed; after the thaw the air was infected by their putrefaction.

5. Bugs, muſketoes, &c. &c. have generally died.

6. The graſshoppers I ſuſpect are gone, not having yet ſeen any.

7. Some ſnakes yet live, but they are not ſo numerous as formerly.

8. I muſt add ſomething remarkable reſpecting fiſh, though I know not whether to refer it to the cold, or ſome other cauſe.

From 14th to 24th of May, after continued eaſterly winds, fiſh were driven on the coaſt in ſuch abundance, that in Rehoboth only two or three hundred buſhels were daily collected, and eaten by the people. Some ſeemed at firſt to be alive, but far the greater part were dead, and many had one eye picked out by the birds while floating on the water. The ſound, or air bladder, of them all was remarkably diſtended, ſo that they could not ſink in the water; this ſeemed to be the cauſe of their death. Theſe fiſh were generally ſea crocus, a few cats, and ſome ſea trout.

The vegetable ſeems to have ſuffered more than the animal kingdom.

Roſemary, of which there were many large and flouriſhing hedges, is totally extinct.

The *pink* is deſtroyed, except a few ſmall roots, covered with leaves, in narrow places.

Grape vines, both native and foreign, are killed, except where they were ſheltered from the winds.

Moſt of the ever-greens, the ſmall *laurel*, the *holly*, the *juniper*, *bear buſhes*, and ſome ſmall *pines*, have ſuffered in the general calamity; and what is ſtill more remarkable, many young *black oaks*, and ſome *white oaks*, from twelve feet high and under, are dead, in bleak places.

Sage, *rue*, *lavender*, *prickly pears*, *ſouthern-wood*, and *ſilk graſs* (a ſpecies of the aloes), are dead to the roots. *Comfrey roots* and *parſley* are much damaged, and the *Catauba* tree is killed in all its ſmaller branches. Two thirds of the *wheat* and *rye* in our country are loſt; and *hoar-hound*, which generally grows all winter, is deſtroyed.

In the ſalt marſhes I found the large *triangular graſs* and the *bent graſs* generally dead from the roots. The marſh at preſent (June) looks red, and ſeems rotten.

XXXIX. *A Deſcription of a new Standard for Weights and Meaſures, (in a Letter from Mr.* John Cooke, *of Tipperary, in Ireland, to* Thomas Jefferson, *Eſq.)*

THE want of uniformity in weights and meaſures is a ſubject of general complaint at preſent; it is an infinite ſource of fraud, and the great obſtacle to domeſtic and foreign commerce.

The firſt ſtep neceſſary to remove this evil is to appoint an univerſal, perpetual, and immutable ſtandard, for length, ſuperficies, weight, and capacity; whereby the inſtruments of meaſurement may be adjuſted, and alſo whereby they may be deſcribed to diſtant countries, and to future ages.

Natural ſubſtances are incapable of furniſhing one of this deſcription. Every thing in the material world is in a ſtate of gradual alteration; it differs from itſelf under different circumſtances, and differs from every individual of the ſame ſpecies.

General and permanent immutability is to be found only in our abſtract ideas; and none of theſe can define dimenſions but our ideas of geometrical diagrams; therefore, if we could diſcover ſuch relations or qualities in a geometrical figure, as are peculiar to it, and as would diſtinguiſh it from all other ſimilar figures, we ſhould have a correct ſtandard; but as every attempt to accompliſh this has failed, we are obliged to reſort to thoſe general qualities of matter which are the moſt durable and leaſt variable.

Of this claſs are coheſion, motion, gravity, &c. upon the laſt of which the following theorem depends, and from which alſo Mr. Huygens has deduced the pendulum ſtandard.

But the pendulum is ſubject to many imperfections; the principal of which are:

1ſt. That the variation of the weight of the atmoſphere affects it.

2dly. It is of different lengths at different diſtances from the equator.

3dly. It requires a force in addition to its gravity, to preſerve it in motion a ſufficient time; and as this may be greater or leſs, in different experiments, it may accelerate or retard the vibrations, and conſequently render the length uncertain.

4thly. Unleſs the pendulum move in a cycloidal arch, its oſcillations will not be perfectly iſochronous, and this has not been effected hitherto.

5thly. Since the pendulum is a meaſure of length only, the meaſures of capacity and weight, if they be deduced from it, will be erroneous in a triplicate proportion of the errors of the pendulum.

The two firſt of theſe faults are common to the ſcheme here propoſed alſo; and if the following theorem ſhould be thought to deſerve attention, it is becauſe the ſtandard deducible from it is not ſubject to the three laſt-mentioned defects.

Theorem.

If there be a cubic veſſel with an aperture in the bottom, which aperture is in a given ratio to the baſe of the veſſel; and if the ratio, between the weight of the water which this veſſel contains when full, and the weight of the water diſcharged from it through this aperture in a given time, be given, the cube itſelf is given.

Demonſtration.

No other ſimilar veſſel will diſcharge a proportionate quantity through a proportionate aperture in the ſame time; for if ſo, the weights of water, diſcharged by two ſuch cubes in the ſame time, would be in the ſame ratio to their diſcharging cubes reſpectively, and conſequently the weights of the diſcharged waters muſt be to each other as the weights of the cubes, that is, in a triplicate ratio of their altitudes; but by the laws of hydraulicks the weights of the water diſcharged in the ſame time from different altitudes, and through different apertures, will be to each other in a ratio compounded of the ſimple ratio of the apertures (which is equal to the ratio of the baſis, which is equal to the duplicate ratio of the altitudes), and the ſubduplicate ratio of the altitudes; that is, the weights of the water diſcharged muſt be to each other in the triplicate ratio of the altitudes, which is abſurd.

In making an experiment according to this theorem, it is to be obſerved, that the edges of the orifice ſhould be as thin as poſſible, and that the veſſel ſhould not be ſuffered to diſcharge ſo much of its contents that the ſurface would approach the bottom.

It is evident, that by this method a ſtandard may be formed for any length, ſuperficies, or capacity, and alſo for any weight, if the ſpecific gravity of the water made uſe of be given.

XL. *Deſcription of a Spring Block, deſigned to aſſiſt a Veſſel in Sailing.* *By* FRANCIS HOPKINSON, *Eſq. of Philadelphia.*

Honoured with the Magellanic Gold Medal, by an Award of the Society, in December 1790.

IT is an acknowledged fact, that when the ſhrouds of a veſſel are braced very tight, ſo as to prevent the maſts from having any play or ſpring, ſhe will not ſail as faſt as when her maſts are permitted to bend a little to the impulſes of the wind. The reaſon is, that the wind is ſeldom uniform in its force for any length of time; and it is impoſſible that a ſudden increaſe of impulſe ſhould *inſtantaneouſly* communicate a proportionable velocity to ſo heavy a body, placed in a reſiſting medium of ſo great denſity.

In ſuch caſe the veſſel is forcibly preſſed into or againſt the water, and is obliged to heel from the blaſt, until a progreſſive motion, adequate to the force impreſſed, can be communicated to the whole maſs. But theſe ſudden preſſures againſt the water, and this heeling of the veſſel, are great obſtacles to faſt ſailing; in as much as they occaſion an unprofitable expenditure of the force which ſhould puſh her forward.

When a veſſel firſt hoiſts her ſails, although ſhe may be in a ſituation to receive the full impulſe of the wind, yet ſhe will not *immediately* proceed with the velocity which ſhe will afterwards acquire from the ſame force: having not yet *got under way,* as the ſeamen expreſs it. Upon the ſame principle, when a veſſel is ſailing at the rate of five knots, if a ſudden blaſt of wind ſhould come, which would enable her to make ſeven knots, ſhe may be conſidered as being perfectly ſtationary with reſpect to the two additional knots, and will require ſome time to *get under way* as to them. Now the effect produced by relaxing the ſhrouds is, that the maſt, receiving the firſt impreſſion of the wind upon the ſails, acts as a ſpring, and yielding to the impulſe, gradually communicates motion to the whole veſſel, giving her time to *get under way,* and occaſioning an eaſy tranſition from one degree of velocity to another: ſo that her way is not checked by her being ſuddenly urged againſt the reſiſting medium on the acceſſion of every new force impreſſed.

But the misfortune is, that this advantageous uſe of the maſt can be exerciſed only to a ſmall extent; for, if it is allowed too much play, it will be in danger of breaking. The object of the preſent propoſal is to enjoy the ſame benefit to a greater extent, and with more ſecurity.

The maſts, yards and rigging of a ſhip receive the firſt impulſes of the wind. All theſe are in ſome degree elaſtic. Every twiſted rope is a ſpiral ſpring, and every ſpar capable of being a little bent. But let us ſuppoſe that the ropes were all compoſed of ſtraight ſtrands, that the maſts and yards were inflexible, and the ſails made of thin light wood; in ſuch caſe, I ſuppoſe, that the veſſel, in ſailing by the wind, would make but little head-way, whatever the ſhape of her bottom might be; but would expend the force of the wind in heeling, and ſlipping to leeward. If this is true, her ſailing muſt be conſiderably aſſiſted by any means that ſhall increaſe the active ſpring of her rigging. For this purpoſe I have contrived what I call a SPRING-BLOCK, to be applied to all ſuch parts of the rigging as will admit of it with ſafety and convenience, and where its operation will be moſt advantageous; but particularly to the ſheet-ropes, and, if practicable, to the dead-eyes in lieu of what are called the chains.

Deſcription.

Plate X. A, fig. 1. is a block made in the uſual manner, having a ring or eye, B, at one end. C is a ſpiral ſpring linked at one end to the hook D E, and at the other to the ring F, which is to be annexed by a ſtaple to the timber-head, or by ſome other means, to the place where it is to be applied. The ſpring, C, muſt be of well tempered ſteel, and proportioned in ſtrength to the ſervice it is to perform. Within the cavity or pipe formed by the ſpiral ſpring, there muſt be a *chain* of a ſuitable ſtrength, called a *check-chain* (repreſented ſeparate at G), connected by links to the rings D and F. When the ſpring is not in action, this chain is ſlack; but when the ſpiral ſpring is extended by the force of the wind as far as it can be without danger of injury, the check-chain muſt then begin to bear, to prevent its further extenſion; and, if ſtrong enough, will be an effectual ſecurity againſt failure.

Fig. 2. repreſents part of the gun-wale of a ſloop, with the ſpring-blocks in action, one of them hooked to a ſtaple in the timber-head, and the other to the corner of the jib.

My expectation is, that a veſſel thus furniſhed will be leſs liable to heel, that ſhe will receive the impulſes of the wind to better advantage, and ſail with a more lively and equable motion, than if rigged in the common way.

Vires acquiret cedendo.

XLI. *A Botanical Deſcription of the Podophyllum Diphyllum of Linnæus.* *By* BENJAMIN SMITH BARTON, *M. D.*

THE *Anapodophyllon* of Tournefort was conſidered as a genus, of which there was only one known ſpecies. When its name was changed by Linnæus to that of *Podophyllum*, the known ſpecies was denominated *peltatum*. Another was afterwards added, with the trivial name of *diphyllum*; and theſe two ſpecies, with their characters, have kept their places in all ſubſequent editions of the *Species Plantarum* and *Syſtema Vegetabilium*. Linnæus, however, had never ſeen the flowers of the latter ſpecies; and in the edition of the *Syſtema*, printed at Vienna in 1770, he expreſſes a doubt whether it may not be a ſpecies of *Sanguinaria*. Clayton, in his *Flora Virginica*, enumerates both ſpecies as indigenous to Virginia, but had not ſeen the flowers of the *diphyllum*. No later botaniſt mentions the plant.

Dr. S. B. often fruitleſsly ſought this ſpecies in the woods of Pennſylvania. Mr. W. Bartram has found it in the country of the Cheerakee-Indians plentifully, but not in flower. Another gentleman has met with it in a rich ſoil near the river Monaunghela, in Pennſylvania, and alſo on the Holſtein, in North Carolina, but not in a flowering ſtate. Mr. Andrew Michaux, a French botaniſt, diſcovered it on the Blue Ridge, near the head of the Roanoke, in Virginia. From a root of the plant, which he ſent to Mr. Bartram, and which flowered in ſpring 1791, in the neighbourhood of Philadelphia, the following deſcription is made.

It was found to belong to the claſs of *Octandria Monogynia* of Linnæus. As to its natural claſs, it would arrange very well between *Sanguinaria* and *Podophyllum*, in Linnæus's 27th natural order of *Rhœadeæ*.

THE GENERIC CHARACTER.

CALYX. A perianthium, conſiſting of three, four, or five (moſt generally of five) equal, concave, and lanceolate leaves, or pieces, rather ſhorter than the corolla, of a pale roſe colour, and falling off ſome time before the expanſion of the flower.

COROLLA. The corolla conſiſts of eight lanceolate, or narrow, ovate, pointed, ſomewhat concave, and ſpreading petals. In figure, they reſemble the ſegments of the flower-cup, but are larger.

STAMINA. The filaments, or threads, are eight in number, ſimple, ſlender, much ſhorter than the corolla*, and inſerted into the receptacle. The *Antheræ* are flat, large, erect, oblong, and incurved.

PISTILLUM. The germen, or ſeed-bud, is ſuperous, large, oblong, or ovate. The ſtyle is cylindrical, thick, and ſomewhat ſhorter than the filaments. The ſtigma is fleſhy, radiated, or criſped.

PERICARPIUM. A large capſule, turban-ſhaped, pimpled, tapering towards the lower part, thin, unilocular, and divided, on the poſterior part, by a longitudinal ridge. It ſplits, or opens, by a tranſverſe ſuture, or lip, which is more than one half the circumference of the upper part.

SEMINA. The ſeeds are from twelve to twenty in number, lying looſe. They are nearly ovate, and ſmooth.

As it evidently appears to be a genus diſtinct both from the *Sanguinaria* and *Podophyllum*, Dr. B. thinks it neceſſary to fix a new name upon it; and he adopts that of JEFFERSONIA, in honour of Thomas Jefferſon, Eſq. Secretary of State to the United States.

One ſpecies only is as yet known. This he names and deſcribes in the following manner:

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* They are about one-fifth of the length of the corolla.

JEFFERSONIA BINATA.

The *root* of this plant is fibrous, very branching, of a pale brown, or dirty yellowiſh, colour, and conſiſting of a cortex, or bark, and a woody part. This ligneous portion is of a more lively yellow than the bark. The fibres, including both bark and wood, are not, in general, thicker than a common pin.

The *ſtalks* are ſeveral: they do not branch out at all, but proceed immediately from the crown of the root, ſupporting the leaves, and the flowers. Both theſe leaf and flower ſtalks are naked, commonly about a line in thickneſs, ſmooth, and of a dark green, ſomewhat purpliſh, colour. After the falling off of the flower, the ſtalks, as well as the leaves, &c. increaſe, very conſiderably, in ſize.

The *leaves* are binate, or two-lobed, each lobe being ſomewhat of a ſemi-cordated form, very entire, ſmooth, and of a ſea-green colour on the under ſide. The principal nerves are five in number, in each lobe.

The *flower-cup* has been already deſcribed.

The *corolla*, or *flower*, is of a fine white colour, and ſtands erect, or horizontal, on the ſummit of the flower-ſtalk. There is never more than one flower on the ſame ſtalk.

The *filaments* have been ſufficiently deſcribed. The *antheræ*, or *ſummits*, are yellow.

The *piſtil* has been deſcribed; as has, likewiſe,

The *ſeed-veſſel.*

The *ſeeds* are nearly of a cheſnut-brown colour.

Obſervations.

The common height of the plant, whilſt in flower, is about ſix or eight inches: after the fall of the flower, it often grows a foot, or ſixteen inches high. The flower continues, for ſeveral days, in perfection and beauty; during which time the germen is viſibly enlarging. The petals now ſuddenly fall off, leaving the germen erect upon the ſummit of the ſtalk. This viſcus increaſes in ſize very rapidly, changing its figure daily. When it is about three fourths of its mature ſize, it is nearly of an obovate, or turbinated form, ſomewhat compreſſed on one ſide. During this ſtage of its growth, we plainly diſcern the tranſverſe ſuture, or lips of the inciſion, mentioned in the generic character. When it is completely ripened, the ſeed-veſſel opens, pretty ſuddenly, at this tranſverſe ſuture, upon which the ſuperior part riſes up, and now it appears like a cap, or helmet, diſcovering the naked ſeeds, lying looſe. The ſeeds are to be diſperſed. The ſtalk ſupporting their capſule becomes cernuous, or bends downwards, the bending being made a little below the protuberant part of the ſtalk, which I have repreſented in the different figures of the ſeed-veſſel, &c.

The ſeed-veſſel is, for ſome time, of a green colour: as it advances in ſize and age, it changes its colour, becoming, at length, of a yellowiſh hue.

In the garden of Mr. Bartram, before mentioned, the *Jefferſonia Binata* flowers early in the ſpring. The ſeeds ripen before mid-ſummer. Soon after this period, the plant withers and decays, but the root continues to live, at a ſmall depth under the ſurface of the ground, increaſing, by off-ſets, on all ſides.

As to its medicinal or other qualities, nothing is yet known. The writer, however, takes the opportunity of ſaying ſomething of thoſe of the *Podophyllum peltatum.*

This is a plant much eſteemed by the Indians, who employ its root as a purgative, emetic and anthelmintic. The common doſe is from 18 to 20 grains in powder. It has the advantage over jalap, in operating in a ſmaller doſe, not ſo often proving emetic, and being leſs liable to gripe, and leſs nauſeous. It has ſomewhat of an anodyne or narcotic quality. Dr. B. adds an obſervation, that hybrid vegetables are frequent in America, particularly among the *Syngeneſiæ*. The genera of *Solidago* and *Aſter*, there, are two families of baſtards. He ſuſpects that the *Jefferſonia* may poſſibly be a hybrid between the kindred genera of *Podophyllum* and *Sanguinaria*.

EXPLANATION of PLATE VI. *Fig.* 1.

N°. 1. The plant, of its natural ſize, during the time of flowering.

N°. 2. 3. 4 and 5. Different views of the ſeed-veſſel. N°. 2 and 3 repreſent the horizontal lip, or ſuture, which afterwards opens, diſcovering the ſeeds, lying looſe, as in N°. 5.—N°. 4. exhibits the ridge on the poſterior part of the ſeed-veſſel.

N°. 6. A leaf, of the common ſize, after the flower has fallen, and the ſeed-veſſel is ripe. Some of the principal nerves of the leaf are repreſented.

N°. 7. The germen, or ſeed-bud, with the ſtyle, and ſtigma, of the ſize they appear a few days after the falling off of the flower.

N°. 8. One of the leaves of the flower-cup.

N°. 9. A ſeed, of its natural ſize, when ripe.

N°. 10. A filament and anthera, of the natural ſize.

N°. 11. and 12. The antheræ, at the time of their ſhedding the pollen, or fecundating duſt, burſting laterally.

XLII. *Obſervations on the Conſtruction of Hoſpitals, by Mr.* LE ROY, *Member of the Royal Academy of Sciences—(Extracted from an Eſſay on the Subject, which, with ſeveral elegant Plans, was tranſmitted by the Author to the Society, but could not be inſerted entire, as it contained many Remarks of a local Nature, reſpecting Paris—only.)*

THE conſtruction of Hoſpitals is in general objectionable, either becauſe many of the wards do not admit of perfect ventilation, or becauſe the air paſſes from one patient over another, by which means contagious diſeaſes are often ſpread.

To avoid theſe inconveniences, a large hoſpital ſhould conſiſt of diſtinct and ſeparate buildings, each forming one ward, erected upon arches or columns, at a conſiderable height from the ground, and ranged at a diſtance from each other, like the tents of an encampment.

The ceiling or roof of each ward ſhould be formed into a number of ſpherical arches according to its ſize, the crown of each arch being in the middle of the breadth of the ward, and opening into a funnel like a common chimney, which ſhould be ſupplied with a vane (reſembling that we call a cowl), ſo that it may always open to leeward.

In each floor, mid-way as to breadth, ſhould be a row of holes at ſuitable diſtances from each other, to admit air from below, ſo conſtructed that the quantity of it may be regulated at pleaſure.

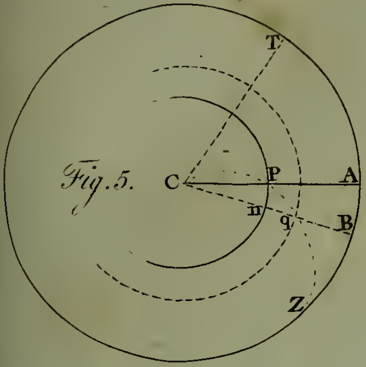


Fig. 5.

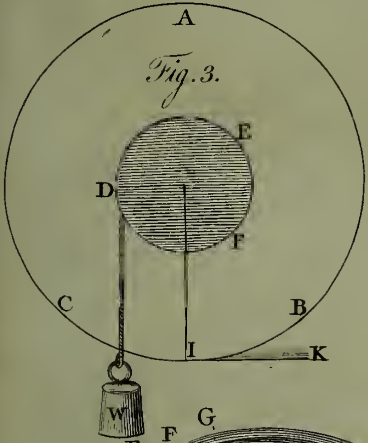
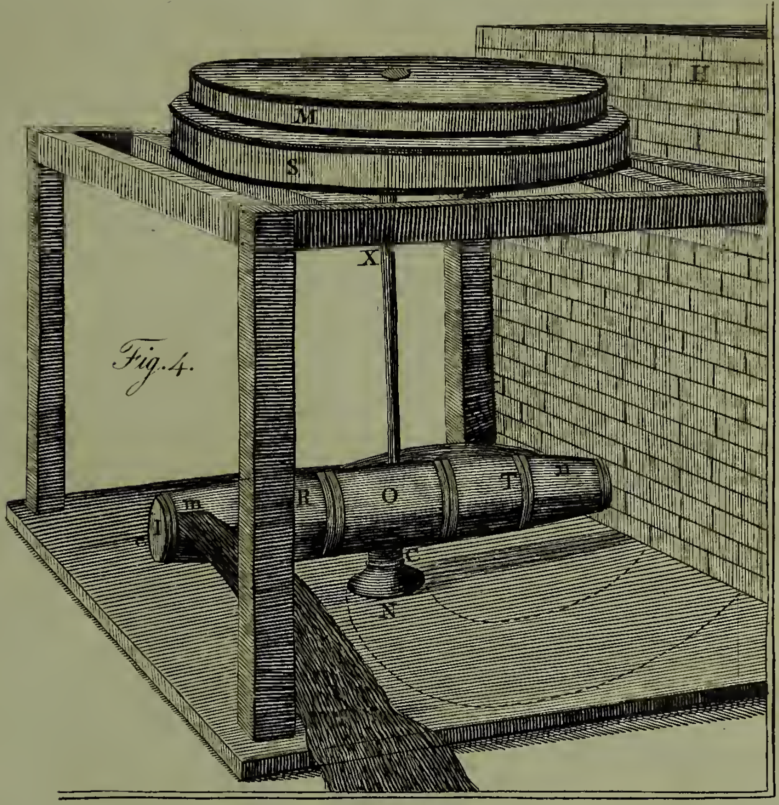


Fig. 3.



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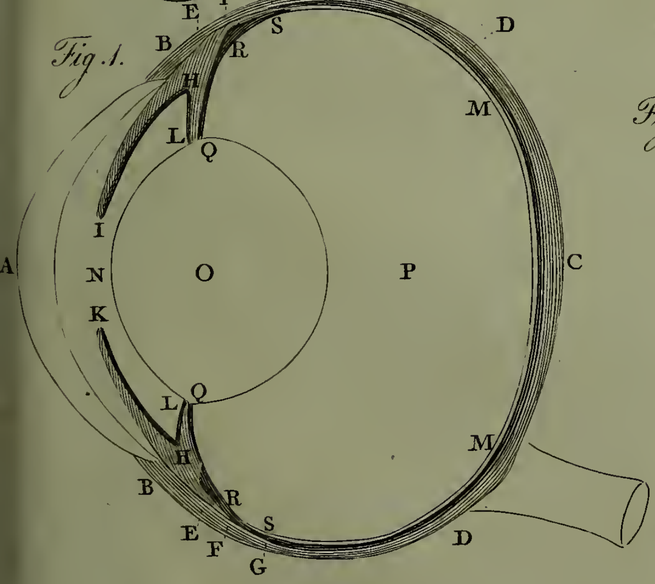


Fig. 1.

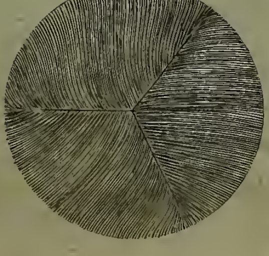


Fig. 2.

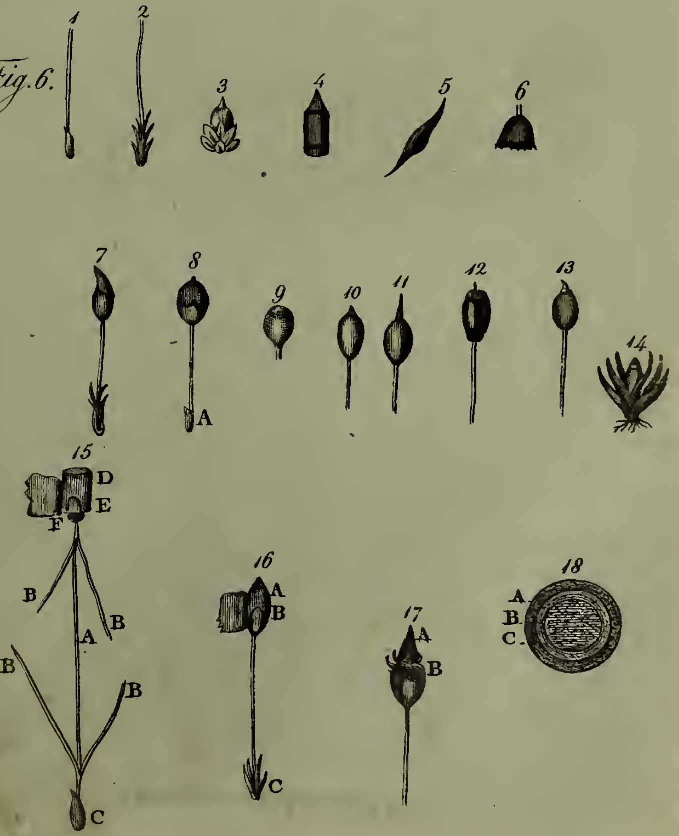


Fig. 6.

Hixon sculpt.

Fig 1

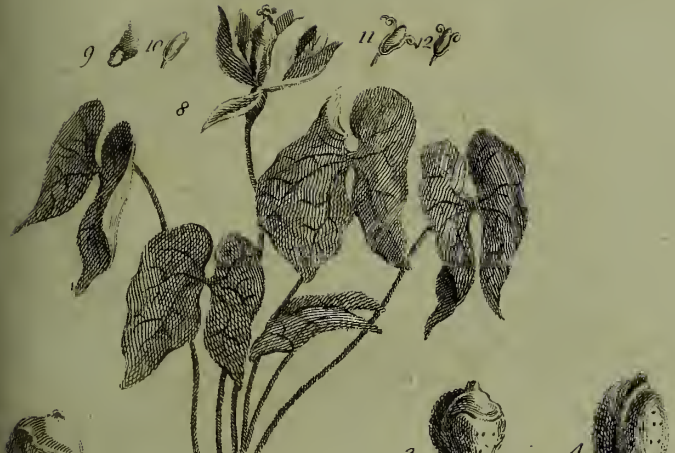


Fig 2

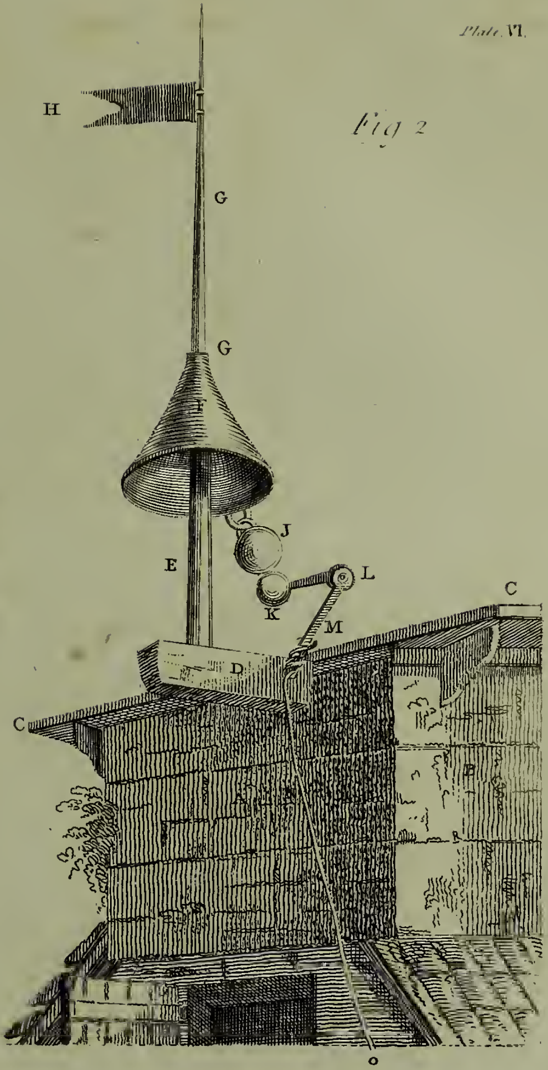
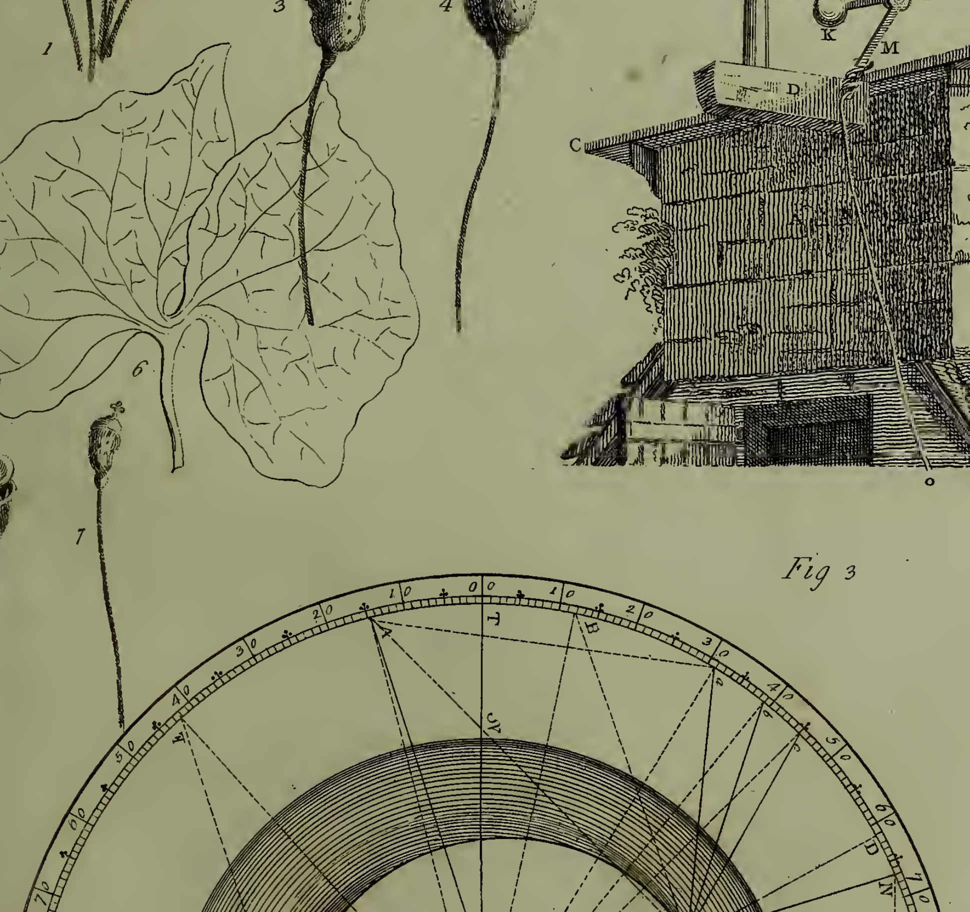


Fig 3



facing page 144

Plate X

Fig. 1.

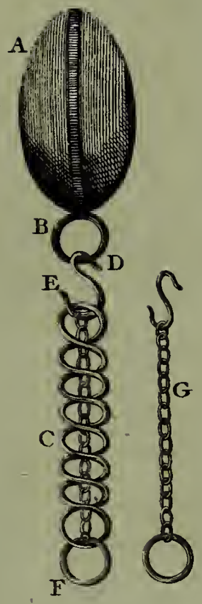


Fig. 3.

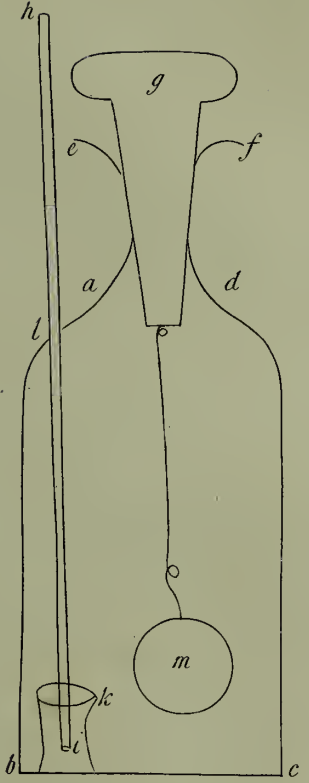
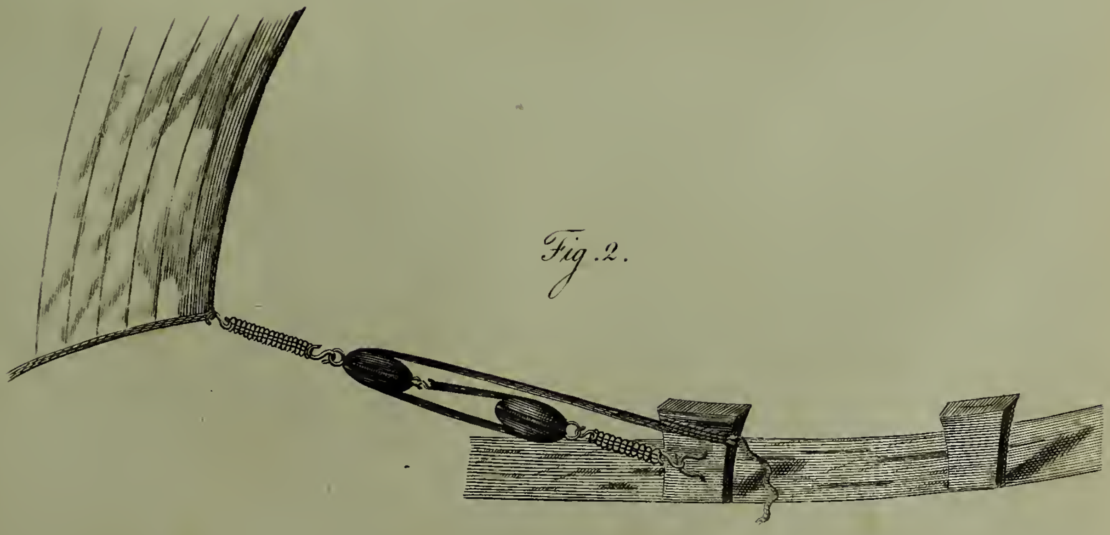


Fig. 2.



In conſequence of this ſtructure, there muſt be a conſtant change of air; for that which is in the lower part of the ward, being warmed by the patients and nurſes, and the neceſſary fires, will aſcend, and in conſequence of the ſpherical conſtruction of the roof, will be directed to the openings in it, and flow through them, while the holes in the floor will afford a conſtant ſupply of freſh air, which will move rapidly, as it enters the room ſo low.

A number of arches with openings is preferable to a ſingle arch in the centre, becauſe the air, in paſſing from the extremities of the room to the centre, flows from one patient over another—and a plane or flat ceiling, even with apertures, is improper, becauſe the upper air at a diſtance from the apertures cannot move to them.

The rooms may be warmed by placing grates or ſtoves over theſe holes in the floor, and no bad effect can be produced by the fire, as the air and vapours will aſcend from it, and go off by the holes in the cieling.—If it be neceſſary to quicken the circulation of air, either on account of the ſluggiſhneſs of the atmoſphere, or of the contagious nature of any diſeaſes in the ward, ſmall fires may be fixed in grates or ſtoves near the openings in the cieling, to increaſe the motion of the air.

To prevent the ſpreading of contagion, as well as to keep the ſick from beholding the ſufferings of each other, a ſcreen of ſuitable height ſhould be placed between each bed.

For contagious diſorders and ſurgical caſes, there ſhould be a number of wards, at a diſtance from the Hoſpital, and to leeward of it with reſpect to the prevailing winds.

Memoirs of the Academy of Science and Belles Lettres at Berlin.

From AUGUST 1786, to the End of 1787. Quarto, 1792.

Conſiderations on Barometric and Hydrometric Meaſurements. By Mr. ACHARD.

IT is the purpoſe of this memoir to prove, that the ideas uſually formed on the barometric and hygrometric ſtate of the atmoſphere are falſe.

The barometer, according to the received opinion of philoſophers, is an inſtrument, by means of which a column of mercury is put in equilibrium with a vertical column of the atmoſphere, and the weight of the latter is determined by that of the former. Mr. A. examines this opinion.

It is proved by the laws of hydroſtatics, that when two columns of fluids, equal or different in ſpecific gravity, and connected by their baſes, are in equilibrium, the ſums of the weights of thoſe parts of theſe fluids, which are in a vertical direction above their common baſe, are equal. This theorem, though proved with reſpect to non-elaſtic fluids, and which would be equally true of thoſe the elaſticity or expanſibility of which was conſtant, is not ſo, where of the two fluids, one is non-elaſtic, and the other elaſtic, or of variable elaſticity or expanſibility. But this is the caſe with reſpect to the column of the atmoſphere put in equipoiſe with that of the mercury in the barometer. Many experiments ſhew, that the different expanſion of the air, owing to variations of temperature, affects the height of the mercury, as well as difference in its gravity does. But there is another leſs known cauſe which produces variations in the expanſion of the air, and this is its combination with the different volatile matters to which it unites itſelf. This combination may be effected either by proper ſolution or by ſimple mixture. In the latter caſe, the elaſticity and expanſibility of the air are not affected; in the former its expanſibility undergoes great changes according to the nature of the ſubſtance diſſolved in it, to its degree of ſaturation, and of heat.

Experiment. (pl. X. *fig.* 3.*)*

Abcd is a glaſs veſſel, the neck of which is cloſely ſtopped with a ground glaſs ſtopper. At *l* it is pierced with a hole, through which is paſſed a glaſs tube *h i* hermetically ſealed at *h*. Its length ought to be ſuch, that, when its lower extremity is about a line diſtant from the bottom of a ſmall cylindrical cup *k* placed in the glaſs veſſel, the part of it *l h* ſhould project eight or nine inches above the hole in the veſſel. The tube muſt be cemented at the hole ſo as to ſuffer no air to paſs. At the lower part of the glaſs ſtopper *g*, is attached, by means of a thread, a very thin glaſs bubble made by the blow pipe, filled with water, hermetically ſealed, and having a little glaſs hook to hang by. The apparatus being thus arranged, the cup *k* is filled with well-dried mercury. By means of a ſpirit lamp, the projecting part of the tube is then heated, whence part of its air is dilated, and eſcapes by its orifice *i*, and on cooling, mercury riſes in it to ſupply the vacuum. This operation is to be repeated till the mercury is ſuſtained in the tube ſomewhere between *l* and *h*. Then ſome ſlips of plate iron,

iron, juſt plunged into melted cauſtic alkali ſo as to receive a coating from it, are as quickly as poſſible introduced through the neck of the glaſs veſſel, which is immediately cloſed again by the ſtopper. The intention of this is, by means of the ſuperior attraction this alkali has for moiſture, to render the air contained in the veſſel as dry as poſſible. It is Mr. de Sauſſure's method of producing the greateſt degree of deſiccation in order to regulate his hygrometers. The apparatus is now left untouched in an apartment, the temperature of which is ſubject to little variation. After the inſtrument has acquired the heat of the external air, the place, to which the mercury riſes in the tube, is marked by a ſilk thread. By a ſudden inclination of the glaſs, in which care is taken not to ſpill the mercury in the cup, the glaſs bubble *m* is then broken againſt the ſide of the veſſel, and its water ſhed. The incloſed air, made as dry as poſſible, begins immediately to diſſolve the effuſed water, and continues doing it to the point of ſaturation. The mercury inſtantly mounts in the tube, and continues doing ſo for about an hour, the degrees of its elevation being found leſs and leſs every ten minutes, till they become inſenſible.

From this experiment it appears, that, all other circumſtances being equal, the expanſibility of air is augmented in proportion to the increaſed quantity of aqueous particles to which it is united.

Similar experiments were tried in ſaturating air with other fluids and volatile ſolids. The general reſult was, that all ſubſtances capable of evaporation in the temperature of the atmoſphere, and conſequently able to contract the union of ſolution with air, augment its expanſibility; except in the caſe of development of phlogiſton, which, by decompoſing the air, diminiſhes the elaſticity of the total maſs. But this only happens where phlogiſton is ſo developed as to be no longer in combination with other ſubſtances; for while this combination exiſts, it does not decompoſe air. Thus, the different kinds of ethers moſt of all augment the elaſticity of air; and next to them, perfectly rectified ſpirit of wine.

The next ſubject of examination was the relation between augmentations of dilatability produced by correſpondent augmentations of heat, in air more or leſs ſaturated with water. For this purpoſe, three glaſs tubes were taken, each $3\frac{1}{2}$ feet long, and of equal bore, about a line in diameter. To each was attached a ball of $1\frac{1}{2}$ inch diameter. After Mr. A. had exactly determined, according to a method deſcribed in a former memoir, the ratio of the capacity of the balls to that of the internal volume of any given extent of the tubes, he filled the three tubes with common air differently charged with water. In one was air dried as much as poſſible by cauſtic alkali. In another, the air was that of an apartment, dry, but uninhabited. In the third, the air was loaded with as much water as it could take, by being ſhut 24 hours in a receiver reſting on a plate of water. Proceeding then after the manner detailed in his memoir on the relation of the dilatability of different ſorts of airs to different degrees of heat, he found, that under correſpondent degrees of heat, the dilatations of airs, more or leſs charged with moiſture, were very different; the drieſt air receiving much the leaſt augmentations of expanſibility, and the moiſteſt air the moſt, from equal augmentations of heat. In repeated experiments, it was always obſerved, that very dry air underwent equal augmentations of volume from equal augmentations of heat, according to the degrees on Reaumur's ſcale, ſo that the dilatation of the air correſponded to that of the mercury by the ſame heat; whereas, the more air was impregnated with water, the more irregular it was in this reſpect, its augmentations rapidly increaſing in progreſſion, as the heat was increaſed.

To return to the barometer. From what has preceded, it appears that the elevation of the mercury is not dependent ſolely on the gravity of the column of air, but alſo on its thermometrical and hygrometrical ſtate. The following remarks may be made on this ſubject. When, from any cauſe, the water diſſolved in air ſeparates from it, and its particles form maſſes only adherent, and not combined with air, the air muſt become leſs expanſible, and conſequently the mercury muſt fall. This ſeparation of the water muſt be followed by its deſcent, on account of its ſpecific gravity, and this deſcent will be more or leſs rapid, and in different forms, according to the temperature of the atmoſphere, as thoſe of miſt, rain, ſnow, and hail. When the deſcent of the mercury is not followed by a ſhower, a wind more or leſs ſtrong never fails to ariſe, which will either in part or entirely carry away the particles of water before they can unite ſo as to form drops. Thus, from the diminution and augmentation of the expanſibility of the air alone, according as it contains more or leſs water, may be explained the correſpondence of meteorological changes with thoſe of the barometer.

It may be here aſked, what is the cauſe of the ſeparation of water from the air in which it is diſſolved? Mr. A. attributes it ſolely to the variations of temperature in the atmoſphere. To be convinced of this, it is enough to pay attention to the drops of water which often attach themſelves abundantly to the inſide of the windows of apartments hotter than the external air; whereas the contrary takes place when, as ſometimes happens in a ſudden thaw, the internal air is colder than the external. In both theſe caſes, the air, loaded with as much water as it can contain, is obliged to depoſit part of it on being ſuddenly cooled.

This memoir is cloſed by ſome remarks on hygrometers.

All hygrometers, whatever be their conſtruction, are formed upon the principle of the augmentation of extent, whether in length or breadth, of the ſubſtance employed as a meaſure, by the action of the particles of water in the ſurrounding air; and this augmentation is ſuppoſed to correſpond to the degree of humidity. On this ſuppoſition, water diſſolved in air muſt be ſuppoſed to act on the hygrometer in the ſame manner as if it were only minutely diffuſed through it. If this be not the fact, the foundations of hygrometry are falſe. In order to aſcertain whether water diſſolved in air acts on the hygrometrical ſubſtance in the ſame manner as when it is only diffuſed, the following experiments were made. As it was enough for this purpoſe that the hygrometer ſhould point out different degrees, without the power of comparing theſe degrees, a catgut with a needle fixed to it was choſen.

Exp. 1. This hygrometer was placed in a glaſs receiver filled with air, ſaturated with water, in the 12th degree of Reaumur's thermometer. After cutting off all communication with the external air, it was put in a place where the temperature was 14 degrees. After ſix hours, the point at which the needle remained fixed was noted. The apparatus was then removed to a place where the temperature was 10 degrees. After twenty-four hours the needle was turned to the ſide of humidity. It was then removed to a temperature of 5 degrees; and in twenty-four hours more the needle had turned conſiderably more to the ſide of increaſed humidity, and the inſide of the receiver was covered with ſmall drops of water. The inſtrument was then taken to a place 5 degrees colder than the freezing point. The ſeparation of water was much more abundant, and the inſide of the receiver was covered with rime; but the needle remained fixed to the former point.

Exp. 2. A ſimilar hygrometer was placed in a receiver filled with very moiſt air, which had no communication with the external air. Being placed twenty-four hours in a temperature of 15 degrees, the point at which the needle ſtood was marked. It was then expoſed for twenty-four hours to 4 degrees. A portion of water ſeparated, which attached itſelf in form of drops to the inſide of the receiver. The air was then changed to another dry receiver, placed in 8 degrees. The hygrometer was ſoon after put in it, and its needle ſtopped nearly at the ſame point as in the laſt obſervation, though a little more on the ſide of moiſture. The ſame operation was repeated, placing the air immediately for ſixteen hours in a temperature 8 degrees below freezing. A very abundant ſeparation of water took place, which turned to ice on the ſides of the receiver. The whole was then placed in 1 degree below freezing, when the needle ſtopped exactly at the ſame point as in the firſt obſervation.

By the firſt experiment it appears, that water contained in air acts on the hygrometer only in proportion as the water ſeparates from the air, and not at all while combined.

The ſecond experiment proves, that a maſs of air may contain very different quantities of water, which the hygrometer does not mark out, provided the temperature be ſuch as to enable the air to hold the water in ſolution. Hence it follows, that the hygrometer only ſhews the quantity of water diffuſed in the air, and not that diſſolved in it. Whence hygrometrical meaſurements are always dependent on the thermometrical ſtate of the air; and the inſtrument is no true meaſure of the quantity of water united to air.

Obſervations on Terreſtrial Electricity. By Mr. ACHARD.

THE electrical conductor in the garden of the Academy deſtined to meteorological obſervations has an inſulated point, eighty feet high, connected by means of braſs wire with an electrometer compoſed of two little balls of pith of elder, hung by threads on the two ſides of a vertical braſs rule, the repulſive power of which when electrified cauſes theſe pendulums to riſe in proportion. The rule and its balls are encloſed in a glaſs globe, nine inches in diameter, which is covered by a glaſs funnel, to prevent its ſummit from being moiſtened in caſe of rain, which would eſtabliſh a communication between the atmoſpheric electricity and the earth. The lower part of the globe, containing the electrometer, is attached by means of a reſinous cement to a plate of braſs fixed by ſcrews to a wooden ſtand, three feet high. To this ſtand is attached an iron bar, which enters three feet into the earth. It is moveable, ſo that it may be brought nearer to, or removed farther from the wire, which forms the communication between the point of the conductor and the electrometer.

On Auguſt 11, 1787, between three and four, P. M. the ſky being quite ſerene, with a briſk N. W. wind, the barometer at 28 inches, $3\frac{5}{10}$ lines, the thermometer (Reaumur's) at $12\frac{4}{10}$ degrees, the declination of the magnetic needle 17°, 54′, de

Luc's feather hygrometer at 34 $\frac{7}{10}$ degrees, I found the balls of the electrometer diverging more than an inch from the rule; the wire from the point of the conductor gave ſtrong and very pungent ſparks. On bringing the hand to the glaſs globe, and then withdrawing it, the electricity, inſtead of being diminiſhed, was much augmented; and the reſult was the ſame on repeated trials. A ſimilar experiment, on the 14th, was attended with the ſame conſequence. As I could not explain this phenomenon on the ſuppoſition that the conductor had received its electricity from the atmoſphere, nothing remained but to ſuppoſe that the whole apparatus had received it from the earth, or the ſtrata of air near it. To aſcertain how far this ſuppoſition was admiſſible, I ſeparated the chain of communication between the electrometer and the conductor, and inſtantly the ſigns of electricity in all the parts diſappeared; ſoon after I rejoined it, and they re-appeared ſtrong enough to ſhow viſible ſparks in full day-light. If the electricity of the conductor had been derived from the atmoſphere, it ſhould have continued to ſhew itſelf in the conductor, notwithſtanding the communication between it and the electrometer was broken off. As this was not the caſe, it was evident that ſuch a communication was neceſſary to the electricity of the conductor. To aſcertain the matter I made further trials.

The communication between the glaſs globe and the conductor being interrupted, I brought my finger to it, but neither at the approach nor during the contact was there any motion in the balls of the electrometer. On removing the finger, however, the balls ſenſibly diverged. The ſame thing happened when I touched the other conducting bodies. I then renewed the communication, without remarking at firſt the leaſt electricity; but after bringing the braſs wire within half an inch of the iron bar going from the electrometer to the ground, the whole apparatus became electrical. From this experiment it appeared, that the electricity of the conductor was a conſequence only of the approach of ſome of its parts to the conducting bodies which communicated with the earth, or of the immediate contact of theſe bodies with the glaſs globe. Hence it is plain, that the electricity of the conductor was not derived from that of the atmoſphere, but of the earth.

In order to make further obſervations on the electrity of the earth, I have conſtructed an inſtrument, which conſiſts of a Canton's electrometer encloſed in an inſulated glaſs globe: a braſs wire, which enters the ground, and is pointed at its upper end, approaches within a quarter of an inch to the electrometer.

Many phenomena may be explained by the electricity of the earth, particularly that of the riſe and fall of the dew, and its greater propenſity to attach itſelf to bodies originally electrical, than to conductors. But a detail of experiments on this ſubject is referred to ſome future occaſion.

On a new very advantageous Method of making White Lead, Maſſicot, and in general of giving to Calxes of Lead different Colours proper for painting in Oil, and in Diſtemper. By Mr. ACHARD.

IN making certain experiments on the decompoſition of common ſalt, for the purpoſe of obtaining its mineral alkali, Mr. A. found, that by triturating litharge with this ſalt, it was converted into a very white calx, which, on expoſure to a gentle heat, took a beautiful yellow. By a ſeries of experiments on calxes of lead thus prepared, he found that the white calx might be ſubſtituted to ceruſſe; and that by different degrees of calcination, different ſhades of colour, from light yellow to brown, might be produced, very proper for the painter's uſe. Specimens of them were ſent to the Academy along with this memoir. Some of theſe were prepared by triturating litharge with an equal weight of common ſalt, and waſhing it with an alkaline lye; ſome with double its weight of ſalt, and $\frac{1}{10}$ of fixed alkali; ſome with $\frac{1}{4}$ its weight of ſalt, and an alkaline lye. They were expoſed to different degrees of calcination, augmented gradually. The advantage of preparing colours from lead in this manner, is a much greater cheapneſs than in the ordinary modes.

Memoir on Abſorption. By Mr. WALTER.

THE purpoſe of this memoir is to refute the opinion generally maintained by the anatomiſts of the Engliſh ſchool, and particularly in the work of Mr. Cruikſhank, of the excluſive action of the lymphatic ſyſtem in the function of abſorption.

Mr. W. begins with a definition of abſorption, its cauſe, the nature of pores, the different kinds of veſſels, and a ſhort hiſtory of the diſcoveries of the circulation, and of the lacteal and lymphatic ſyſtems. Theſe, as well-known matters, we ſhall not farther notice, but ſhall proceed directly to his remarks on the Engliſh writers.

The doctrine of *tranſudation after death* has been brought to the ſupport of the new ſyſtem of lymphatic abſorption. Dr. Hunter and Mr. Cruikſhank ſuppoſe that tranſudation through pores does not take place till after the death of the ſubject. Dr. H. aſſerts, that if an artery in a dead ſubject is injected with a very ſubtile matter, the injection will paſs into the cellular ſubſtance; but if it be coloured with vermilion, not a particle will paſs this way, unleſs the coats of the arteries be lacerated. On this Mr. W. remarks, that if the injection be very well prepared and applied, the matter eaſily penetrates into the cellular ſubſtance and the cavity of the inteſtines, without any rupture or extravaſation. The obſtacle uſually met with proceeds from the particles of the vermilion, which not being ſufficiently levigated, obſtruct the minute ramifications of the veſſels. A great degree of ſkill is alſo neceſſary in puſhing injections, ſo as to go far enough, without ſuch force as may lacerate.

Mr. Cruikſhank obſerves that, in opening a dead body, the gall-bladder, and contiguous part of the duodenum and colon, are found tinged with the hue of the bile; and alſo, that the exterior coat of the ſtomach is of a deep red, from the exudation of the blood; whereas neither of theſe circumſtances are found in opening a living animal. Mr. W. on the contrary, has always found, even in living animals, and in men opened very ſoon after a violent death, that the gall-bladder and neighbouring inteſtines were tinged with the colour of the bile. He has found the external coat of the ſtomach of a pale red; but ſuppoſing it were deeper after death, he ſhould impute it, not to exudation, but to the accumulation of blood in the veins, which takes place after that period.

Mr. Cruikſhank adduces, as a further argument, the eaſe with which a ſolution of glue injected into the coronary vein paſſes into the pericardium; or one into the veins of the pia mater paſſes into the ventricles of the brain; whereas no ſuch thing happens during life. Mr. W.'s reply to this is, that on injecting with a moderate degree of force, the liquor does not eſcape into theſe cavities; that even this force is greater than that with which the blood is impelled during life; and that, in injecting, the natural courſe of the fluids in the veins is inverted, going from the trunk to the branches, inſtead of the oppoſite direction. He therefore imagines, that the ſucceſs of ſuch injections proves either laceration of the veſſels, or the exiſtence of *abſorbing orifices*, from the minute ramifications of the veins.

In order to prove that tranſudation is poſſible, even in living ſubjects, Mr. W. remarks, that all the membranes containing fluids are furniſhed with phyſical pores—that they are alſo pierced by an infinite number of veſſels, which are ſurrounded with a looſe cellular tiſſue, where they paſs—that theſe pores, acting like the orifices of capillary veſſels, would imbibe the fluids ſuited to their ſpecific gravities—and that hence not only tranſudation, but abſorption, through them is poſſible. As an anſwer to Mr. Cruikſhank's objection, that were this the caſe there could be no dropſy of the thorax or abdomen, he obſerves, that the pores of the pleura and peritonæum may not be capable of admitting water, or that it may be poured out by the arteries too rapidly to be re-abſorbed in equal proportion.

Mr. Cruikſhank having aſſerted, that the odour of the ſemen is proper to its nature, and not derived from the exhalations of a volatile fluid produced near the rectum, and penetrating through the pores of the ſeminal veſſels, Mr. W. firſt lays it down as a matter of fact, that the ſemen has a volatile odour, to which its energy is attached, and that this odorous principle is capable of being abſorbed. He relates his examination of the body of a female, who died immediately after coition, in whom the fringes of the fallopian tubes were found embracing the ovaries, while the tubes contained ſemen, and their veſſels were diſtended with blood, as if injected. He agrees with Haller, in imputing the nauſea in women, after conception, in part to the abſorption of ſemen. He next conſiders Mr. Cruikſhank's aſſertion, that during life there is not only no tranſudation, but that there is even no ſecretion of a fluid of a remarkably fetid and penetrating odour. In contradiction to this, Mr. W. ſays, that on opening the abdomen of a living man, or other animal, a very penetrating and fetid odour is perceived; and that the reaſon why the abdominal muſcles are not rendered putrid by it, as they are after death, is, that the exhalations are immediately re-abſorbed, and are either employed to give acrimony to other ſecretions, as the bile, or carried off by the emunctories. The ſame may be ſaid with reſpect to the fetid matter of lumbar abſceſſes before they are opened.

Proceeding now to the queſtion of abſorption itſelf, the writer firſt conſiders that of the chyle; and diſcuſſes the arguments brought to refute the co-operation of the vena portarum with the lymphatic ſyſtem, in this function. He gives an abridgment of the experiments of J. Hunter and Cruikſhank, and makes a general objection to the inferences drawn from them, which is, that the extreme ſufferings of the animal muſt greatly alter the action of the veſſels, and, in particular, muſt probably cauſe ſuch a contraction in the venous abſorbing orifices, as to prevent them from performing their office. He confirms Boerhaave's argument in favour of the abſorption of the vena portarum, that its blood is not diſpoſed to coagulate; and queſtions the ſolidity of Mr. Cruikſhank's oppoſite aſſertion; and likewiſe attempts to ſhew that the chyle and lymph, which this vein may be ſuppoſed to abſorb, would have the effect of preventing the coagulation of the blood. He then conſiders Boerhaave's argument, that this vein is too capacious for its correſpondent arteries, whence it is probably deſtined to the reception of an abſorbed fluid. He allows weight to Mr. Cruikſhank's reply to this, viz. that all other veins alſo much exceed their arteries in capacity; but obſerving that the quantity of blood is greatly diminiſhed during its courſe through the arteries by the ſecretions, and by nutrition, he thinks that the ſuperior capacity of the veins, notwithſtanding this defalcation of the blood they receive, is a good argument for the ſuppoſition of their abſorption. From a minute examination of the peculiar ſtructure of the vena portarum, Mr. W. is convinced, that it is intended to contain a quantity of fluids beyond that brought to it by the blood-veſſels. He diſtinguiſhes, however, two kinds of nutritive fluids abſorbed from the inteſtines; the one, that which under a milky appearance is imbibed by the lymphatics; the other, more groſs and aqueous, which is taken in by the branches of the vena portarum.

Perfect obſtructions, and even lapidification, of the meſenteric glands are not uncommon, in which caſe nutritive abſorption could not be performed by the lymphatics. Mr. W. gives a figure of the lacteals and glands of the jejunum completely obſtructed and indurated, in a man of thirty; and obſerves, that obſtructions of this ſort, from viſcid and earthy juices, are very common in children. In very old people it is uſual to find the lymphatic glands entirely ſhrunk away, and the veſſels going to them obliterated. Yet theſe, if living on ſucculent diet, are ſufficiently nouriſhed.

The next proof advanced, of the abſorption of the inteſtinal veins, is the ſmallneſs of the thoracic duct in proportion to the quantity of fluid which muſt paſs through it, were the lymphatics the only abſorbents. This is particularly remarkable in the copious and quick ſecretion of urine in drinking freely. Mr. Cruikſhank has endeavoured, by calculations of the diameter of the thoracic duct compared with the velocity of the fluid moving through it, to do away this objection; but Mr. W. combats his arguments with other calculations and obſervations, in which he compares the great velocity of the blood in its veſſels with the ſlowneſs of the lymphatic fluids, and concludes, that therefore the latter cannot bring neceſſary ſupplies to the former. With reſpect to the ſecondary lymphatic canal in the anterior mediaſtinum, anaſtomoſing with the thoracic duct, on the aid of which Mr. Cruikſhank places much dependence, Mr. W. traces it principally from the liver, and aſſerts, that it may be filled by an injection from the vena portarum.

Mr. Cruikſhank brings as an argument for the abſorption of the lymphatics, that, in caſe of a total obſtruction of the cyſtic duct, when the gall-bladder was diſtended with bile, he has found the lymphatic veſſels of this bladder full of bile. Mr. W. however, on his own principles, accounts for it by ſuppoſing, that after death the bile tranſudes through the teguments of the gall-bladder into the cellular tiſſue interpoſed between them, whence the lymphatics ariſe, and not from the internal ſurface of the gall-bladder.

He paſſes to the ſpeedy cures of dropſies which have long remained unaltered, which Mr. Cruikſhank attributes to a ſudden action of the lymphatics, rouſed to renewed power by ſome irritation. This idea is ſupported by Mr. Maſcagni's experiments of injecting, ſoon after death, a coloured liquor into the thorax and abdomen, when the lymphatics of theſe cavities, and thoſe on the ſurface of the inteſtines, were always found to have imbibed the liquor. Mr. W. in ſimilar experiments, found no ſuch reſult; and Mr. Cruikſhank himſelf, in his elaborate deſcription of the lymphatics, gives no room to ſuppoſe that he has obſerved any in the pleura or peritonæum. In many caſes of diſeaſe, in which a coloured liquor has been formed in theſe cavities, no ſign of it has ever been diſcovered in the lymphatic ſyſtem. As to the theory that dropſies are carried off by the ſudden renewed action of the abſorbents, Mr. W. oppoſes it by another hypotheſis, that the change is in the ſecreting arteries, which from ſome cauſe ceaſing to pour out their fluids, the venous abſorption, which was all the while going on, is now able to drain away all the formerly effuſed liquor.

Mr. Cruikſhank found that, in the bodies of thoſe who died of hæmoptyſis, the lymphatics were filled with blood. Mr. W. never obſerved this; but were it to be admitted, he thinks it would make nothing againſt the abſorption of the veins; ſince in the lungs there is exhalation enough to require the moſt ſpeedy abſorption; and from the viſcous matter mixed with the blood effuſed in pulmonic hæmorrhages, part of the fluid might ſtill be left after death in the lymphatics. As to Mr. Cruikſhank's idea that air penetrates into the blood-veſſels of the lungs, and mixes with the blood, Mr. W. thinks it neceſſarily requires venous abſorption, ſince the rapidity of the blood's motion in the arteries of the lungs would infallibly prevent the penetration of any particles which did not come in the direction of that motion. He does not, however, admit the theory of the colour of the blood being derived from the air, but attributes the increaſed redneſs of the blood in the lungs to the compreſſion of its globules in paſſing through the ſinuoſities of the pulmonary veſſels.

He proceeds to abſorption on the ſurface of the body. He begins with a brief account of the anatomy of the teguments, in which he divides the cutaneous veſſels into two claſſes; thoſe which open beneath the cuticle, and thoſe which penetrate it. The former principally ſecrete the mucous juice of Malpighi, of which, thickened by abſorption, and dried and condenſed by the air and friction, the cuticle is formed, which is therefore an inorganic ſubſtance. As to the net-work of Malpaghi, or rete mucoſum, he thinks it entirely an imaginary body, and only formed by the anatomiſt in ſeparating ſome of the internal layers of the cuticle. Exhalant and abſorbent veſſels alſo pierce the cuticle, and come to the ſurface of the body, where they effect tranſpiration and reſorption. Their orifices, however, are not to be detected while the cuticle is entire; the reaſon of which, Mr. W. thinks, is, that they receive a ſort of ſheath from the cuticle. This ſo contracts the orifices, that injections will not penetrate. But if the cuticle be ſtripped off, all the extremities of the veſſels will then be truncated, and an injection will now paſs to the very ſurface. On the ſame hypotheſis the effects of bliſters may be accounted for, which firſt by their ſtimulus occaſion an increaſed ſecretion of the mucus of Malpighi, which detaches the cuticle from the cutis, and breaks off the ends of the penetrating veſſels which conſequently pour out their contents; and re-abſorption cannot take place while the cuticle continues entire.

The partiſans of excluſive abſorption by the lymphatics deny that the veins carry their extremities to the ſurface of the body. Mr. W. aſſerts the contrary, from his ſucceſs in making a moſt minute injection from the veins alone, in which their orifices can be diſtinctly ſeen with the microſcope. A ſtill more deciſive proof he finds in the vaſcularity of ſteatomas, hydatids, polypuſſes, and other excreſcences, which are full of veins and arteries, that are prolongations of the cutaneous veſſels; whereas no lymphatics have ever been traced in them. His general concluſion, therefore, is, that lymphatics exiſt in the ſkin, originating from its interior ſurface, and the cellular membrane, and that they abſorb; but he denies that they pierce the cutis and cuticle ſo as to abſorb from the ſurface of the body. Profeſſor Haaſe of Leipſic, however, aſſerts that he has puſhed mercury, in an injection of the lymphatics, as far as the exterior ſurface of the ſkin. Mr. W. makes various objections to this experiment, attempting to ſhow the probability of a laceration of the lymphatics, and that, at moſt, the lymphatics could only reach the outer ſurface of the cutis, and not penetrate the cuticle. As to the profeſſor's explanation of the œdematous legs of pregnant women from compreſſion of the lymphatics of the pelvis and ilia, Mr. W. remarks, that, were this the cauſe, the lymphatics of the lower extremities muſt be found greatly diſtended in conſequence of a compreſſion ſo long continued, which is not the caſe.

The writer terminates his memoir with the following concluſion:—The lymphatics are abſorbing veſſels properly ſo called; and in all parts where there is a cellular ſubſtance, they partake with the veins the office of abſorption. They abſorb the chyle in conjunction with the vena portarum. In the breaſts of women, the lymphatics alone perform the abſorption of the milk. On the other hand, the veins alone perform abſorption in all the cavities of the body, and on all its ſurface.

Memoir on the Rupture of Dykes. By Mr. SILBERSCHLAG.

THE importance of this ſubject, and the circumſtances referred to in the diſcuſſion, being local, we ſhall not occupy the attention of our readers with an abridgment of it.

On the Inclination and Variation of the Magnetical Needle. By J. E. SILBERSCHLAG.

THE obſervations on the magnetic needle are introduced by a previous inquiry into the forces of the elementary particles of body, from which, and not from matter conſidered as ſuch, are ſaid to ariſe all the phænomena of nature. The elementary particle, or element of body, is the original cauſe of all changes offered to the ſenſes; and it is contended, that ſubſtance itſelf is only force, and its internal eſſence conſiſts only in force. To thoſe who find it difficult to conceive of force without a ſubſtance as the ſubſtratum for its action, the argument of Baumgarten may be applied. " Force, ſtrictly ſpeaking, is either ſubſtance or accident. It is not accident, " when there is a ſufficient reaſon for all thoſe things, which are appropriated to any " ſubſtance. Therefore it is ſubſtance : and what indeed is that ſubſtratum in which " force is ſuppoſed to exiſt ? A nameleſs thing, to which there is no mean of appeal- " ing." Hence, the Leibnitians are right in ſuppoſing the whole viſible world to exhibit phænomena only from elements, whoſe effects are obſervable by the ſenſes.

The following are the eſſential characters of the elements. 1ſt. The element produces its effect from itſelf alone without foreign aid. 2. Elements are ſufficient alone for themſelves: being once created, they endure, and not being compoſed of parts, cannot be penetrated, diſſolved, or deſtroyed by an external and finite power. 3. They act not by mechanic impulſe, but by communicated energies, which alter the ſtate of neighbouring bodies. 4. The extent of this energy may be called the dunamick ſphere, whoſe centre is the element or ſubſtance itſelf.

It is allowed that there can be no action without reaction. Hence, to every element, reaction muſt be attributed, equal to the force in the contrary direction. Let ABCD (plate VII. fig. 1.) be the dunamick ſphere, a the force acting towards the periphery, then x will be the renitence towards the centre. As this renitence cannot loſe itſelf in vacuo, the dunamick centre oppoſes it by a renitence in the oppoſite direction y, which produces a force b acting in an oppoſite direction to the force a. On theſe renitences depends the eternity of the elements; for, ſuppoſing an exploſion from an internal force, ſince that cannot exiſt without an equal internal reaction, by every renitence the force emitted is reſtored to the acting element. There can therefore be no loſs of power; every effect is brought back again to the dunamick centre.

Neither of the renitences can be changed into its oppoſite. For the renitence x is the ſufficient cauſe of the renitence y. If y could be changed into x, then x would be both cauſe and effect, a poſition which involves a contradiction.

Let a, with the pointed arrow, denote a force, which may be called anteriour, then b, as a blunt arrow, may be called poſteriour, then forces produced by anteriour or poſteriour forces are called homogeneous, but heterogeneous, if the anteriour of one element acts upon the poſteriour force of another. The action is called harmonical, as in fig. 2 and 3, when the force of one element has an influence upon that of the other in the ſame direction ; diſharmonick, as in fig. 4. when the two forces oppoſe each other. The active force is diſtinguiſhed by Latin, the paſſive by Greek letters.

Homogeneous force, acting harmonically, increaſes, heterogeneous weakens paſſive renitence.

In fig. 2. a and α, b and β act harmonically, and the power of α and β is increaſed by the action of a and b ; but the force and renitence are equal, and ξ and υ are of the ſame kind as x and y ; therefore, α and β react with increaſed force on ξ and υ, which are repelled to the dunamick centre. Or ſuppoſe a and b to enter into α and β, then the powers of α and β, as to action and renitence, are doubled, and attraction neceſſarily ariſes. In fig. 3, the oppoſite takes place, and repulſion ariſes.

Repulſion alſo ariſes from homogeneous forces acting oppoſite to each other diſharmonically.

In fig. 4, force a repels the renitence x, and α the renitence ξ. The dunamick centres are therefore repelled; and, as in fig. 5, the ſame thing will take place in a ſeries of elements.

When heterogeneous forces act on each other diſharmonically, there is attraction.

The forces a and b, fig. 6, ſeem to oppoſe each other; but, as they are heterogeneous, the one does not take away the other. b has an influence on the renitence x, and a on the renitence y, and both renitences are oppoſite to each other. Hence the renitence y, through the power b, draws back the renitence x to its part, and a the renitence y in the ſame manner, ſo that by preſſion from behind, they mutually approach each other.

When homogeneous or heterogeneous forces act diſharmonically upon ſome intermediate object, all action is deſtroyed, and the body remains unmoved.

Let M (fig. 7.) be acted upon by the element A in the direction AC. Let D be the energy of A, producing the renitence x, which will neceſſarily bring back M to A, or there will be attraction. But in fig. 8 and 9, the two equal homogeneous forces A and B act diſharmonically upon the object M: with whatever force A and B act upon M, it will, by the renitences xx and yy oppoſe them, and remain at reſt.

If the element M ſhould be acted upon by the different forces of neighbouring elements in an oblique direction, there will be attraction.

In fig. 11, M is acted upon by two anteriour forces; fig. 12, by two poſteriour; fig. 13, by an anteriour and poſteriour together. From the compoſition of motion, the body muſt move in the diagonal, which cannot be done without a ſpecies of attraction.

Let A, fig. 14, be the ſtronger ſubſtance, acting upon M, which is able to receive only a certain degree of the energy of A, and let B be the point of ſaturation, beyond which M is incapable of receiving the force of A. Then M, attracted by A with the force V, will go towards A to the point B, and there remain; beyond which point it would be repelled by A, from its incapacity to receive the remaining force B A. This accounts for the planets and comets not falling into the ſun; and the laſt conflagration or new creation of the earth by fire, predicted in the ſcriptures, will not originate from too great an acceſs to the ſun, or a burning comet, but from a very different cauſe.

The action of an element is in every direction. Hence we may conſider it in the centre of a dunamick ſphere, which is divided, fig. 15, into two hemiſpheres, the one having only anteriour, the other poſteriour forces. AC, dividing the hemiſphere into two equal parts, is called the dunamick æquator, and B and D the dunamick poles.

The force of one line being inverſely as the radius, the force in a circle will be inverſely as the ſquare of the radius, and the force of the whole ſphere inverſely as the cube of the radius. On this latter poſition is founded the Keplerian law, that the ſquares of the periodick times of the planets are as the cubes of their diſtances from the ſun.

Let SPHR (fig. 16.) be a dunamick ſphere, and c its centre, B a force acting upon it heterogeneouſly in reſpect of a; there will be attraction.

The force B finds in b an homogeneous force, acting harmonically, therefore it ſtrengthens its renitence y; and on the other hand, the force of a weakens the renitence of the heterogeneous x. The renitence y being increaſed, and x weakened, c is attracted towards B.

Let the homogeneous force A (fig. 17.) act diſharmonically upon a, then the element will be repelled.

A, by its diſharmonick direction, pervades the homogeneous a; x is increaſed, and y decreaſed, and therefore the element muſt recede from A.

A compound dunamick ſphere, as repreſented in fig. 18, is made by ſeveral elements aſſociating their powers together in one centre. Such a ſphere will, like the ſimple ones, have heterogeneous hemiſpheres. For the dunamick centres muſt attract each other, or the elements, bound by no common tie, would ſeparate, and the ſphere muſt be deſtroyed. In (fig. 19) is repreſented a ſphere, in which the homogeneous powers meet diſharmonically in the centre, and conſequently produce an inteſtine commotion of the elements. This ſhews us how the firſt ſtamina of the world were glewed as it were together into material particles, by the force itſelf of the elements, to whoſe power the imagination can ſcarce ſet a bound. Hence the hardneſs and elaſticity of bodies, the changing of ſolids into vapour, and that vehement exploſion which takes place, when, by fire, the dunamick ties are broken aſunder.

To apply theſe principles to magnetiſm. Let a ſheet of paper be covered with ſteel filings, and on them a magnet be placed, the particles will arrange themſelves as they are repreſented in fig. 1, plate VIII.

1. The magnet affects every particle, and forms in each contrary poles, by which they attract each other anteriourly, poſteriourly, and laterally, cohere and make a ſpecies of furrows. The cuſps are gently turned round, from which it is clear, that the magnetick force is of ſuch a nature, as from itſelf to produce heterogeneous poles.

2. S and N are the centres of the oppoſite poles, to which all the rays are directed. M the mean diſtance.

3. AX may be called the major, BC the minor magnetick axis. DE, FG, paſſing through the poles, may be called polar lines.

4. Within the polar lines is included the middle ſphere of the magnetick ſyſtem, SBNCS; without which are the northern and ſouthern imperfect hemiſpheres.

5. As long as BC is leſs than SN, the figures will be elliptick ſpheroids, but the magnetick poles muſt not be confounded with elliptical foci. When SN and BC are equal, a perfect ſphere is formed; if BC increaſes, the ſphere is compreſſed at the poles. Perhaps it will be better to call BC the magnetick equator.

6. The greateſt attractive force is in the margin of the magnet, particularly near HI and KL, leſs in the middle of the ſides, and leaſt of all about the equator.

Since there is no force in elements without renitence, and no anteriour without a poſteriour renitence, from which ariſes an heterogeneous force diametrically oppoſite, this univerſal principle muſt take place in magnets. Hence it is clear, that all the rays emitted of powers, produce heterogeneous powers, hidden in the magnetick maſs, ſo that the external northern pole produces ſouthern powers within the body, and the external ſouthern produces internal northern powers.

The load-ſtone (plate VIII. fig. 2) is cut by the equatorial line AB, whence the heterogeneous powers proceed, ſo that the part C (fig. 3) protrudes the ſouthern S, and the part D, the northern pole N; theſe contrary powers having been concealed before within the magnet.

In every magnetical body there are polar centres, in which the magnetick force ſeems to be concentrated, and to emanate in a ſtar-like form.

Let a, b (fig. 5) be two anteriour external, and c, d poſteriour internal powers. There will be ſome point p, where they meet diſharmonically, and, from the equal contrary force, muſt be at reſt. The power e, pervading the whole axis, muſt touch this point. The intermediate powers f and g, ſince they cannot fall upon e without a repulſe, muſt be directed to the polar centre p, and the ſame may be ſaid of the other intermediate powers. Thus a ſtar, ſuch as the ſteel filings indicated, will be formed.

Between the two poles is a middle ſphere (plate VIII. fig. 1), compoſed of innumerable elliptick ſpheroids. For the magnetic influence, emanating in a ſtar-like form from the poles, and occupying the intermediate ſpace, muſt produce different ſpheres. The particles of ſteel filing having each its ſeparate poles, and following the traces of the polar rays of the magnet SMN, muſt make a ſeries of ſpheroids, and there will be as many minor axes, as there are appearances of furrows. To theſe ſpheroids may be applied all the properties of the ellipſe ariſing from the equation $ay^2 = abx - bx^2$

The magnetick needle (fig. 4) always follows the direction of the tangent TG. Let S and N be magnetick centres, SL and LN rays proceeding from them, and meeting in the elliptick circumference, where the needle is placed. The needle cannot follow at the ſame time the directions SL and NLO, and therefore takes the middle way LG, the direction of the tangent.

Hence, given the two poles S, N, their diſtance SN, and LM the diſtance of the needle from the major axis, to find the angle of declination GLM, we have to find the ſubtangent MG, $= \frac{2ax - 2x^2}{a - 2x}$; and then by trigonometry the two ſides MG, ML, being given, the angle GLM is eaſily found.

From what has gone before, the prodigious attractive force of magnets is eaſily accounted for. In magnetick bodies there are internal powers of an oppoſite nature to the external, and with the great power of the elements we are acquainted. Since the magnetick force cannot be material, it muſt be ſubſtantial: and as all matter conſiſts of an aggregate of ſubſtances or powers, which have equal forces and renitences, from whence proceed attraction and repulſion, theſe eſſential forces muſt be attributed to magnetic ſubſtances. There are many bodies, whoſe particles adhere ſtrongly together, which do not attract other bodies; thus the magnet attracts only iron; for, as the whole force of ſome bodies is ſo occupied in keeping their own particles together, that they cannot act upon others, ſo it is with the magnet in moſt caſes, except that of acting upon iron. The magnet poſſeſſes elements, which are not reſtrained from propagating their power through intermediate ſubſtances upon another body, and thus the ſurrounding bodies cannot prevent the action of the great magnet within our planet. By friction a ſimilar power is excited in artificial magnets: and this power is not propagated by any effluvia, but by the action of ſubſtance upon ſubſtance, till it finds elements of the ſame kind, which, by this action, may be excited to reaction.

To apply the principles of dunamicks in demonſtrating the cauſe of attraction or repulſion, let two magnets (fig. 6. let. A) be diſpoſed with the northern pole of one, N, againſt S the ſouthern pole of the other. The external anteriour powers aaa of the pole N approach the interiour homogeneous powers bbb of the pole S harmonically, and in the ſame manner the external powers ccc of the pole S coincide harmonically with the interiour powers of the pole N. Therefore the internal renitences on both ſides being increaſed, and the external weakened, the magnetical bodies muſt be attracted to each other. In the ſame fig. (let. B) the caſe of repulſion is evident.

In attraction the magnets A, B (fig. 7) adhere by immediate contact, and the poles S, N, coaleſce in D. M with its equator follows the poles, and goes to L. In O there will be a new magnetick ſphere ſhewn by the ſteel filings. The magnetick needle oo is parallel to the axis NS. In fig. 1, plate IX. are ſeen the effects of the union of the poles of the ſame name. In the firſt caſe all the poſteriour tendencies bbb (fig. 6, let. A), of the ſouthern pole S, and ddd of the northern pole N, are obliged, from the weakening of the renitences ccc and aaa to retreat, and drive the poles neceſſarily to the place where the magnets coaleſce. The ſeat of the equator is on the ſame principle changed, and it reſts, where in the concourſe of oppoſite powers there is an equilibrium. The ſphere OO is produced in the ſame manner, as in ſingle magnets the ſphere between the poles is made. The needle is parallel with the axis, being attracted equally by the conigutous harmonick poles SN. In fig. 1, plate IX. the appearances are equally obvious.

To give a needle the magnetical power, the part intended to point out the north is to be touched with the ſouthern pole, and the ſouthern part with the northern pole of the magnet. For the ſouthern pole of the magnet gives its ſouthern powers, and the northern its northern powers internally to the needle, whence the needle emits contrary powers from the maſs. This is ſeen clearly in fig. 2, plate IX. where the northern pole N radiates internally by poſteriour forces, and internally by anteriour forces, and the ſouthern in a contrary manner. To make this inſtrument perfect, there ſhould be an equality of powers on both ſides of the axis, that the needle may not be attracted by the pole of the earth more on one ſide than the other. Hence all ornaments at the points ſhould be avoided, which may, by introducing ſeveral poles, make an aberration. The needle alſo ſhould not be of too great a length, leſt, by the too great ſeparation of the poles from each other, they ſhould not be able to communicate a ſufficient quantity of force in oppoſite directions. But the ſimpler the needle the more perfect. The longer they are, the greater ſhould be the breadth of the head and tail, leſt too many magnetical ſpheres ſhould be formed. There ſhould not be alſo a greater quantity of matter on one than the other ſide of the axis, or the point of the needle will not ſhew the true place.

To make artificial magnets, let an iron rod A (plate IX. fig. 3) be fixed vertically in the ground, and after ſome time it will be impregnated with magnetick influence; ſo that in our hemiſphere the ſouthern pole of the needle B B will be attracted to it at the bottom, and the northern pole C C at the top. At the top of the rod A, let ſome ſteel bars be applied, and rubbed with any peſtle, and then at the lower part, till they have received all the power which they can contain. Thus we are to proceed rom ſmall to greater bars, and theſe are to be rubbed with ſmaller ones till no more force can be admitted. The iron rod A performs the part of a pump, by which the magnetick power is extracted from the bowels of the earth, and communicated gradually by friction to the ſteel bars. The communication of this power may be compared to the lighting of a torch by a lighted torch; and as the elements of light, though not apparent, are ready in the firſt torch, ſo by friction the magnetick force is rouſed into action.

All magnetiſm proceeds from a magnetick body in the middle of our globe. Its rays in our northern hemiſphere may be compared with the anteriour powers in the elements of matter. That the head of the needle may verge to the north, it muſt be ſo affected with magnetiſm, that the anterior powers may poſſeſs the internal maſs, and the poſteriour eradiate from the ſurface. That internal powers correſponding harmonically with the anteriour rays of the ſubterraneous magnet may be excited in the head of the needle, it muſt be touched with the ſouthern pole of a magnet. For this pole emits from its ſurface anteriour rays, correſponding diſharmonically with the rays of the ſubterraneous magnet, and muſt therefore be repelled by it; and if the northern head of the needle is rubbed with theſe anteriour powers, they will inſinuate themſelves into its maſs, and being fixed in it, will emit poſteriour heterogeneous powers from the ſurface. Now, as attraction ariſes from the concurrence of exteriour heterogeneous powers diſharmonically, and interiour homogeneous powers harmonically, the head of the needle, touched by the ſouthern pole of a magnet, muſt point to the north, and the oppoſite end, touched by the northern pole, muſt point to the ſouth.

The exiſtence of a great magnet within the earth is clearly ſhewn by the inclination of the needle. If the poles of this body were in the axis of our globe, there would be indeed an inclination, but no variation of the needle from the meridian line; and therefore the poles of this magnet muſt be in ſome other ſituation. From the obſervations uſed by Wilkins, the magnetical equator appears to be depreſſed to 15° ſouth latitude, in the longitude of 155°, and elevated again by Cunningham's obſervations to 19° northern latitude. The magnetical axis is therefore inclined to the terreſtrial equator, and the magnetical centre is not in the centre of the earth, or the declination of the northern equator would not be greater than that of the ſouthern.

The ſituation of the magnetical poles may be found from the three following obſervations: in long. 350° at lat. 30° the inclination of the needle = 65°; in lat. 38° it is 69°; and in lat. 45°½ it is 75°. To this meridian line therefore, let three lines be drawn with theſe inclinations, and the point within the earth, in which they meet, is one of the poles.

From 15° ſouth lat. to 19° north lat. draw the magnetical equator, and from the pole a perpendicular to this line to an equal diſtance on the other ſide, and the two poles will be given. If the magnetical axis ſhould cut the terreſtrial axis, there would be two oppoſite places given on the earth without any variation of the needle; but it is found, that the line void of variation not only paſſes through ſeveral meridians, but cuts the equator in two places not oppoſite to each other. Theſe are in long. 340, and 141, and as there is no variation of the needle when the magnetical axis is parallel to the terreſtrial, the plane of the magnetical ſphere, in which there is no variation, paſſes through the degrees of long. 340, and 141.

With a globe of pure loadſtone 4½ Rheinland inches in diameter, all the phænomena of inclination and variation have been ſhewn, and in this globe the three centres of magnetiſm, magnitude and gravity were ſeparate. If, therefore, the centre of gravity of the magnetical globe ſhould coincide with the centre of the earth, the globe muſt have a rotation with the earth, though the two other centres are not in the ſame place. The magnetical globe cannot however be fixed to the ſhell of the earth, but muſt move within it, like Saturn in his ring, for it has a rotation, though a very ſlow one, of 10° in ſeventy years in a direction contrary to that of the earth.

To find the diſtance of the northern pole of the magnet a P from a in the 30th degree of latitude, where the inclination of the needle is 65°.

Let a, b, c, be the three places, having lat. 30°, 38°, and $45^\circ\frac{1}{2}$, in the long. 350°, from whence the poſition of the magnetical pole was determined ; and let the radius of the earth = 1000. Then a C c = 15°..30′, and the two equal ſides of the triangle Cac, with the angles, being given, the chord ac is found = 270. In the triangle acP are given the ſide ac, and the angles Pac, Pca ∴ the ſide aP is eaſily found = 622.

To find the diſtance of the northern magnetical pole from the centre of the earth.

In the triangle aCP, are given aC, aP, and angle CaP, from which is found CP = 509, and PCa = 31°.. 5′.

To find the place where the needle is in a direction perpendicular to the ſurface of the earth.

This place muſt be D, from whence a line drawn to the centre of the earth paſſes through the magnetical pole, and DCI = PCa + aCI = 31′.. 5. + 30° = 61°.. 5′ = the latitude of the place.

To find the longitude of D, the magnetical plane, CLF paſſing through the equator in G, long. 340°, and on the oppoſite part with 141°, and the ſegment making CLI parallel to the meridian PDS is diſtant 10° from it in L = the diſtance DG in the equator. Hence in the triangle PBL, BL = 10°, and BP = 28°.. 55′ being given, the angle DPE is found = 20°.. 2′, which being added to 330°, gives 350°.. 2′ for the longitude.

To find the length of the magnetical axis 2 PM.

In the triangle APa are given aP, Aa, being the chord of an arc of 45°, and the angle AaP being = to AaC + CaP, of which AaC is given from the angle ACa being given ∴ AP is given = 10006 and the angle aAP, and conſequently CAP, but the magnetical equator is from obſervation a chord of 176° ∴ MAC = 2° is given, and conſequently the angle PAC is given ; from which and the given ſide PA in the right angled triangle PAM, the ſide PM is found = 462 and the magnetical axis = 924.

From the ſame data is found AM = 894.

To find the degree of latitude, where the needle has a given degree of inclination.

In the triangle cPC, the latitude of c is now ſuppoſed not given, but the angle CcP, and the ſides CP, Cc are given, from which the angle cCP is found, to which add the angle P C X, a given angle, and c X, the complement of the latitude of the place is found.

The needle muſt be in a horizontal poſition, where both poles act upon the needle at equal angles, which can be only where the plane of the magnetical equator interſects the ſurface of the earth; in other places it inclines according to the difference of the ſines, under which it is affected by the polar forces, and the difference of the angles of incidence determines the angle of inclination.

As the inclination of the needle depends on its being affected by the magnetical polar forces, ſo the variation proceeds from the different angles, which in various places the magnetical meridians make with the meridians of the earth. Theſe angles are calculated in a ſimilar manner, and maps made, deſcribing the variation of the compaſs according to this author's ſyſtem; but as they are both too numerous and expenſive to be inſerted in this work, it is ſufficient to have ſhewn the general ſyſtem from whence mathematicians, if the data for the exiſtence of the magnetical globe, and the ſituation of its pole ſhould appear ſatisfactory, may eaſily deduce the reſt. Future obſervations, the author tells us, muſt determine whether the axis changes its inclination to the plane of the equator, and alſo whether the rotation of the magnetical globe is uniform. But before this is done, tables might be made like thoſe of the nautical almanack, by which, from knowing the changes in variation and inclination, the longitude at ſea would be diſcovered.

Chymical Reſearches on Adamantine Spar. By Mr. KLAPROTH.

THIS ſtone is the production of China and Bengal, whence it has been brought within a few years to England. The firſt chymiſt who made it known to the public was Mr. Sage, in the ſecond volume of his *Analyſe Chimique.* He makes it a granite, compoſed of felt-ſpar, black ſchoerl, and quartz. Something more preciſe as to its external characters is given in a writing inſerted by Meſſrs. De la Metherie and the Abbé Hauy, in Rozier's Journal for January and February 1787. The preſent is the firſt chymical analyſis that has been made of it.

Adamantine ſpar offers two varieties of the ſame ſpecies, according as it comes from China or Bengal. That of China affects a priſmatic form of ſix ſides, without pyramids; each priſm being from half an inch to one inch in length, by three quarters of an inch in thickneſs. Its colour is a grey, variouſly ſhaded. The ſolid fragments are opake, but when reduced into lamellæ, or viewed in its ſaliant angles, it is diaphanous. The fracture is ſhining; it has a very fine foliaceous or ſpathoſe texture, which makes the priſms appear longitudinally ſtriated. The lateral ſurfaces are commonly covered with a coat of brilliant ſilvery mica, the little ſcales of which ſtrongly adhere to the ſtone. On this coat are ſprinkled points of red felt-ſpar. On ſome of theſe ſtones are very fine particles of a ſulphureous pyrite.

Adamantine ſpar is extremely hard, ſo as to cut glaſs, rock-cryſtal, and other hard ſtones. Its ſpecific gravity is as 3710 : 1000. The Chineſe variety has the accidental character of containing particles of iron, which are attracted by the magnet, and are diſſeminated through its ſubſtance in form of ſmall cryſtalliſed grains. When the ſtone has been reduced to moderately fine powder, the magnet eaſily collects theſe particles.

The Indian variety of this ſtone, called in the Bombay dialect *Corundun*, is diſtinguiſhed from the Chineſe by a whiter colour, and a more decided ſparry texture. The particles of iron in it are ſmaller, and are not ſo properly diſſeminated through its ſubſtance, as ſcattered on its ſurface.

The Chineſe kind was the ſubject of the following experiments. After being kept an hour in a ſtrong red heat, the ſtone loſt $\frac{1\frac{5}{6}}{100}$ of its weight, but its ſubſtance had undergone no other change than that of becoming a little whiter. The flame of a blow-pipe produced no effect upon it, either with mineral alkali, borax, or microcoſmic ſalt. On proceeding to the analyſis, the firſt operation was to wrap the ſtones in ſeveral folds of ſtrong paper, and break them groſsly on an anvil. The pureſt pieces were then ſelected, and repeatedly heated and quenched, but without loſing any of their hardneſs. They were then reduced to a very fine powder in an agate mortar. Of this, 300 grains were put into a retort, with twice the weight of aqua regia. By a ſtrong digeſtion a martial tincture of a gold yellow was obtained. The digeſtion was repeated with freſh aqua regia. The ſolution was precipitated by cauſtic volatile alkali. The precipitate waſhed, and made red in the fire, proved perfectly obedient to the magnet. No calcareous earth was detected by the addition of aërated volatile alkali. The powder remaining, after the ſubtraction of the iron, was of a clear aſh-grey. It was mixed with twice its weight of alkali of tartar, and made red in the fire for two hours in a ſilver crucible. The maſs was then digeſted in diſtilled water, but from the alkaline ſolution reſulting, nothing was precipitated by an acid. The proceſs was repeated with cauſtic alkali, and the maſs was afterwards digeſted in marine acid; but nothing was extracted, except ſome particles of iron which had before eſcaped. On edulcorating and drying the remaining powder, which was of a whitiſh grey, its weight was found to be 240 grains; whence the iron it had contained appeared to be 60 grains, or a fifth of the whole.

Theſe 240 grains were mixed with four times their weight of cauſtic mineral alkali, and expoſed in a ſilver crucible during five hours to the ſtrongeſt heat the metal could ſupport. The very hard ſolid maſs that reſulted was boiled in diſtilled water, and the ſolution being then ſaturated with marine acid, a white earth with very little coherence was precipitated. A ſlight addition of acid took up again the earth, which appeared to be aluminous earth. It was anew precipitated by ſaturating with alkali, and then was collected. The reſidue left on the filtre, which was of an iſabelle colour, no longer poſſeſſed the ſame tenacity. On pouring to it four parts of aqua regia, the whole was almoſt immediately converted into a very tenacious gelatinous maſs. Four more parts of aqua regia were then added, and the mixture digeſted to ebullition. The ſolution was then diluted with boiling diſtilled water, and filtred. By ſaturation with alkali it gave the ſame precipitate of aluminous earth. The ſtony reſiduum was ſtill 140 grains. The ſame proceſs as the laſt deſcribed was repeated upon it, and another portion of earth was obtained. The reſiduum was 103 grains. Another operation reduced it to 92 grains. This was put to digeſt with ſix parts of very pure nitrous acid. The powder at the bottom of the veſſel appeared at firſt like fine ſand; but as ſoon as the ebullition began, it ſwelled, roſe to the ſurface, and took on the appearance of thin flakes. On continuing the digeſtion, the powder ſeparated again, and re-aſſumed its firſt form. The acid during this proceſs took up ſome more aluminous earth, which was ſeparated from it by precipitating with an alkali. The undecompoſed part remaining weighed 74 grains. This was again ſubmitted to calcination with cauſtic alkali as before, and earth was procured from it. A repeated digeſtion of the reſiduum in acid alſo afforded more aluminous earth. The proceſſes were repeated, to the amount of eleven calcinations and fuſions in alkali, with all ſorts of proportions and degrees of heat. Nothing more being now to be gained in this way, the ſeveral precipitates were put to examination, after aſcertaining the identity of the two ſorts. They were digeſted in one part of oil of vitriol with four of diſtilled water. A conſiderable portion of the earth was ſpeedily diſſolved, but another portion remained untouched, nor was acted upon by freſh addition of vitriolic acid, diſtilled from it to dryneſs. The ſolution of earth in the acid, after the addition of a very little alkali of tartar, was evaporated, and regular cryſtals of alum were obtained from it; but at every cryſtalliſation a white earth was ſeparated, which was incapable of ſolution in acid. Theſe laborious proceſſes, then, had detected two ſpecies of earth; one, aluminous; the other hitherto unknown. By treating this earth again with alkali and acid, and comparing it with a ſiliceous earth put in ſimilar circumſtances, it plainly appeared not to be ſiliceous. Twenty grains of the earth were then mixed with the ſame quantity of dry aërated mineral alkali, and expoſed in a clay crucible to the fire of a porcelain furnace. By this proceſs a very hard glaſs was obtained, of a greeniſh and changing white. In its fracture manifeſt traces were diſcovered of a needly texture, diverging from a common centre, which was a point in the inferior ſurface.

With reſpect to the proportion of the elements compoſing adamantine ſpar, the iron, which is properly only mixed with it, and not a conſtituent part, has been obſerved to amount to one fifth. Of the remaining 240 grains, the aluminous earth, diſſolved in vitriolic acid, gave 2 oz. 6 gros of cryſtals of alum, in which the proportion of pure earth of alum is 154 grains. The weight of the ſecond element was 53 grains when perfectly dried. To this may be added 24 grains of inſoluble reſiduum, which manifeſted the ſame properties; which makes 77 grains of the new earth. Nine grains were loſt in the operations. Thus, two parts of earth of alum, and one part of an earth the properties of which are not yet aſcertained, are the heterogeneous elements which compoſe adamantine ſpar.

Chymical and Mineralogical Memoir on Uranium. By Mr. KLAPROTH.

THE foſſil which yields by analyſis the metallic ſubſtance in queſtion is found principally at Johanngeorgenſtadt in Saxony, and at Joachimſthal in Bohemia, where the miners have given it the name of *Pechblende*. It has been known by few mineralogiſts; and there is reaſon to doubt whether what Cronſtedt, Wallerius, and Brunnich mention by the name of Pechblende and Pecherz, is this mineral. Werner, who denies that it is a Blende, takes it from the claſs of ores of zinc to thoſe of iron; but he has raiſed doubts againſt his own claſſification, and by his laſt hypotheſis

would

would regard it as a ſpecies of Wolfram. But this notion will be refuted by the following experiments.

Two varieties of Pechblende may be eſtabliſhed. The firſt is blackiſh, inclining to deep grey, with a rather dull brilliance, and a ſomewhat unequal texture, and of which the ſmalleſt parts affect a flattened conchoid form. It is moderately hard, and its powder is black. The middle ſpecific gravity is 7,500. Among it are often diſcovered parcels of Galena, of a whitiſh grey; this heterogeneous matter is diſtributed in neſts, or in little bands, or infinitely fine veins. The ſecond variety is characteriſed by a fuller black colour, ſometimes with reddiſh ſhades. Its brilliancy is more marked, and approaches to that of pit-coal. Its hardneſs is leſs than that of the former. The blackiſh powder it gives on trituration has a greeniſh caſt. This kind is met with in compact maſſes, of various ſize, generally fixed between layers of a micaceous ſchiſt, in a ſtate of begun decompoſition. It is not uncommon to meet with, in the inſide of this ſtone, threads of a particular metallic earth, of a ſulphur-yellow, rarely reddiſh. Pechblende is alſo often combined with a cryſtalliſation in quadrangular tables, known by the name of green mica. All the ſpecimens here deſcribed were taken from the mine of Georgwagsfort, at Johanngeorgenſtadt. At the mine of Neujahr, the Pechblende is fixed between alternate layers of a brown iron ore. The ſpecimens from Joachimſthal are accompanied by heavy red ſpar.

Pechblende expoſed to the blow-pipe without addition is infuſible. With mineral alkali or borax it yields a grey button, little tranſparent, and which appears only ſcorified. With microcoſmic ſalt it affords a green tranſparent pearl, perfectly vitrified. The little parcels of lead ſometimes found in theſe buttons are foreign to the mineral.

Half an ounce of Pechblende in powder was expoſed to a briſk fire in a luted retort. It underwent a loſs of ſeven grains. A ſmall portion of ſulphureous acid was found in the receiver, and a little ſulphur had ſublimed into the neck. An equal quantity of Pechblende was then calcined in a teſt under a muffle, till all its ſulphur was diſſipated. It loſt 20 grains. The ſame portion being again expoſed an hour to the fire, it had regained eight grains.

The mineral was next examined with acids. Oil of vitriol diluted with three parts water effected no ſufficient ſolution, and only gave a weak greeniſh tincture. On diſtilling from it concentrated oil of vitriol to dryneſs, only one-fourth of the reſiduum was ſoluble in water, to which it gave a green tincture. The acid came over phlogiſticated. Nitrous acid produced a complete ſolution. Half an ounce of the firſt kind of Pechblende in powder was digeſted with a gentle heat in nitrous acid, ſomewhat weakened. A ſlight re-action ſoon came on, with red vapours riſing from the matraſs. Succeſſive portions of the acid were added, till the black colour of the foſſil vaniſhing ſhowed that the ſolution was perfect. Having diluted the ſolution in water, which was a greeniſh yellow, and filtered it, there was left on the filtre a reſiduum of a whitiſh grey, weighing when dried 16 grains. On heating it, it burned with a ſulphureous flame. After the combuſtion it was reduced to 10½ grains. The remaining grey and divided earth was ſiliceous, and aqua regia took from it ſome martial particles. Half an ounce of the ſecond kind in the ſame manner digeſted with nitrous acid gave a gelatinous ſolution, of a very bright green, in which were diſſeminated light flakes of a yellowiſh grey. On filtering the ſolution, there was left a reſiduum of a reddiſh grey, weighing 26 grains, of which nine grains were ſulphur, the reſt a ferruginous gangue. In another ſolution of eight ounces of fragments of Pechblende, mixed with its matrix, in 24 ounces of ſtrong nitrous acid, there was left a reſiduum of $4\frac{1}{2}$ ounces, of which a drachm was ſulphur. The ſolution, concentrated by abſtraction of the acid, let fall a heavy, white, cryſtalline powder, of 50 grains, which proved to be nitre of lead.

The marine acid only imperfectly diſſolves Pechblende, but mixed with a third of the nitrous, it diſſolves it as completely as nitrous acid alone. Four times its weight of aqua regia poured upon half an ounce of Pechblende almoſt diſſolved it without the aid of heat. A gentle digeſtion completed the ſolution, and ſulphur ſwam on its ſurface. After the addition of water and filtration, the dried reſiduum weighed 13 grains, which, by burning off the ſulphur, were reduced to eight grains of a ſiliceous gangue. The ſolution, which was varying between light yellow and green, gave, on cooling, ſome white needled cryſtals, which were plumbum corneum. The ſolution, poured off clear, and ſet by in a cool place, yielded a conſiderable quantity of fine cryſtals of a bright greeniſh yellow, formed in tablets of ſix faces.

From the above ſolutions, phlogiſticated alkali precipitates the metallic ſubſtance of Pechblende with a deep reddiſh-brown colour, like that of Kermes mineral. This is one of its ſureſt characteriſtics. Copper, indeed, thus precipitated, puts on a deep brown colour, but the copper precipitates in flakes, whereas that of Pechblende is uniformly diffuſed through the liquor. What neareſt approaches to it is the ſame precipitate of calx of molybdena; but its red colour is much leſs deep than that of Pechblende; and moreover the two minerals are eaſily diſtinguiſhed by their other characters. If the Pechblende is mixed with a few particles of iron, its firſt precipitate is dirty and blackiſh, inclining to blue, and it is not till cleared of this that the true appears. Liver of ſulphur precipitates it with a very deep browniſh yellow. Tincture of galls affords only a ſcanty black precipitate; but on the addition of a little alkali, a chocolate-coloured precipitate is obtained. The precipitates produced by alkalis are yellow; that by the volatile is always more or leſs dirty; thoſe by the two fixed are of a lemon colour when they are cauſtic, of a whitiſh yellow when aërated. If the acid is ſuperſaturated by adding more aërated alkali than is neceſſary, a great part of the precipitate is re-diſſolved by the aerial acid. This ſolution being filtered, the Pechblende, by ſaturation with the nitrous acid, is precipitated in a lemon-yellow. Cauſtic alkali forms no ſuch ſolution.

The yellow precipitate of Pechblende is very ſoluble in all the acids. That in the vitriolic depoſited firſt ſome vitriol of lead. By evaporating the ſolution a little, a lemon-coloured ſalt cryſtalliſed in ſmall heaped priſms. From the nitrous ſolution ſome nitre of lead firſt ſeparated, after which the ſolution left to itſelf yielded fine tranſparent cryſtals in tablets of ſix ſides, ſome of them three quarters of an inch long, and one-fourth broad, of an agreeable greeniſh yellow. The marine acid ſolution depoſited a little lead in very fine needles, and on evaporation gave yellowiſh green cryſtals, the fundamental form of which was rhomboidal. Pure acetous acid, concentrated by freezing, diſſolves by the aid of heat this metallic calx, except a very ſmall reſiduum. The cryſtals obtained by evaporation were of a topaz-yellow, in long quadrangular priſms terminated by quadrangular pyramids; ſome of the priſms were an inch long. If theſe cryſtals are calcined by a gradual heat, the acid evaporates, but the metallic calx retains its cryſtalline form. The phoſphoric acid alſo effects a ſolution, but it ſoon grows turbid, and the calx combined with the acid precipitates in yellowiſh irregular flakes, little ſoluble in water. The ſame phoſphoric ſalt is produced by adding the acid of phoſphorus to a ſolution of the foſſil in the acetous acid.

The next experiments related to the ſolution of Pechblende in alkalis by the dry way. Half an ounce of it in powder was triturated with an ounce of alkali of tartar, and melted in a crucible. The maſs was of a black grey, hard and compact; its fracture was foliaceous. On lixiviating in water and filtering, the Pechblende was left unchanged, and ſcarcely diminiſhed. The lye was colourleſs, and its taſte, except a ſlight flavour of liver of ſulphur, was purely alkaline. On ſaturation with nitrous acid it gave ſome flakes of ſiliceous earth, which, after drying, weighed four grains. A crucible being made red, a mixture of Pechblende, with thrice its weight of nitre, was injected by ſmall portions. The maſs ſtrongly efferveſced, but with a very weak detonation. After keeping it half an hour in a white heat, it was of a chocolate brown; and the reſiduum, after lixiviation and filtration, was of the ſame colour. The ſolution contained a conſiderable quantity of nitre not decompoſed, and an acid precipitated from it a very little ſiliceous earth.

The reduction of the metallic principle was the next object. In trials with the blowpipe, the yellow metallic calx gave the ſame reſults as the Pechblende in its natural ſtate, except that the pure calx took a grey brown colour; and melted with mineral alkali and borax, it gave a brighter brown and purer button, than that from the melted Pechblende. In the crucible, the Pechblende mixed with borax and powdered charcoal, and alſo mixed with black flux, and covered with ſea ſalt, was melted by a ſtrong fire in a wind-furnace. The reſult was an opake blackiſh grey ſcoria, but without any ſign of reduction. The yellow calx, treated in a ſimilar manner, gave ſimilar reſults. It was then attempted to effect the reduction by the addition of phlogiſton alone. A hundred and twenty grains of the yellow calx were made into a paſte with linſeed oil; the oil was then conſumed on a teſt. There remained 85 grains of a heavy black powder. This was put into a crucible, and the void ſpace filled with powdered charcoal. The cover was luted on, and the crucible expoſed to the medium heat of a porcelain furnace. By its ſide was placed a crucible with mangeneſe ſimilarly prepared. On removing the crucibles, the manganeſe was found perfectly reduced; but the Pechblende was found in a heavy maſs, ſo little coherent that it broke between the fingers in a deep brown powder, of a fine grain, with a little metallic ſplendour. On pouring nitrous acid to it, the acid acted briſkly upon it, with heat and red vapours, which proved that there was a real reduction of the calx, though heat enough had not been employed for its fuſion. This imperfect regulus was then put into an aſſay crucible, the inſide of which was covered with powder of charcoal. Above it, was ſtrewed half its weight of powder of calcined borax, and the reſt of the crucible was filled with charcoal. The cover being luted on, the higheſt degree of heat of a porcelain furnace was applied. The regulus was now found in a ſolid maſs, formed by the union of little metallic grains, conglutinated by the action of fire. The ſubſtance was porous and ſpongy; exteriorly of a deep grey, but the ſurface, where newly expoſed by a cutting inſtrument, was of a bright brown. Its poroſity prevented its having a very marked metallic ſplendour. It had little hardneſs, being very eaſily acted on by the file and knife. Its ſpecific gravity was 6,440. Small portions of it expoſed on charcoal to the blow-pipe ſuffered no change. Some parcels being mixed with microcoſmic ſalt, the pearl, which immediately vitrified, was covered with a ſilvery white pellicle, formed of very ſmall globules. The button of glaſs was of a graſs-green. On continuing the fuſion, the metallic pellicle penetrated ſtill farther into the button, which at length put on the appearance of an opake porous ſcoria, of a dirty green.

A mineraliſation of this regulus with ſulphur was next attempted by mixing one part of the yellow calx with two of ſulphur. It was diſtilled in an earthen retort, when moſt of the ſulphur ſublimed. The reſiduum was a compact maſs, a good deal reſembling, in its colour and fracture, Pechblende of the ſecond variety. By a ſecond ſublimation the ſulphur was almoſt entirely ſeparated from the maſs, leaving a black grained powder.

Some experiments were then made relative to the colouring properties of this metallic calx, mixed with frits, or applied to the coating of porcelain. The different mixtures gave glaſſes of brown, yellow, orange and green hues.

From the experiments above related, it is clear, that Pechblende cannot be admitted among the ores of iron or zinc; nor in the claſs of foſſils which contain Tungſtein or Wolfram; nor, in general, in any of the eſtabliſhed claſſes of mineralogy; but that it ſhould be received as a proper and ſimple metallic ſubſtance. It ought therefore to have a new name; and the author of this paper has applied to it that of *Uranium*, in conformity to the new planet of Herſchel, which has been named Uranus.

Beſides the ores of ſulphureous Uranium, it has been found in the mine of Georgwagsfort, under the form of a metallic calx. This is the metallic earth which was ſaid to accompany the ſecond variety of ſulphureous Uranium. It appears under a great number of ſhades, from pale ſulphur yellow to brown yellow. When bright yellow or reddiſh, it may eaſily be recognized, becauſe, being diſſolved in nitrous acid, it gives, with phlogiſticated alkali, a red-brown precipitate. The more highly coloured earths are all more or leſs martial. This calx of Uranus has hitherto been taken for martial ochre, or the decompoſition of the micaceous ſchiſt which is its matrix.

A foſſil, falſely called *green mica*, and met with in the ſame mine, may alſo be reckoned among the ores of Uranium. It is found in the crevices of the micaceous ſchiſt, and alſo upon the yellow calx of Uranus, in quadrangular and ſometimes cubical lamellæ. Its colour is emerald-green, apple-green, or pale green, with all the ſhades to ſilver white. This ſpecies is alſo found, but rarely, at Eibenſtock, ſometimes upon granite, ſometimes upon a brown quartz approaching to horn-ſtone. Though it was doubted whether this foſſil was a true mica, its nature was little known till Bergman, on examining a very ſmall quantity of it, thought he diſcovered copper mineraliſed by the marine acid, and combined with argillaceous earth. Some ſyſtems have ranked it according to this idea. Mr. Werner places it among the clays, under the name of *Chalcolithum*. But various experiments ſhow that this foſſil is no other than calx of Uranium cryſtalliſed and tinged with copper; for, after all the coppery particles were extracted from its nitrous ſolution, by means of volatile alkali, the remainder yielded the precipitates by which Uranium is characteriſed.

In a mineralogic ſyſtem there ought to be aſſigned to this metal a new genus, among the ſemimetals of difficult fuſion. The following three ſpecies may be eſtabliſhed.

1. *Sulphureous Uranium* (Uranium ſulphuratum).
    - a. Deep grey, often with traces of Galena.
    - b. Black, having the appearance of pit-coal.
2. *Earthy Uranium* (Uranium ochraceum). Sulphur-yellow, lemon-yellow, yellow-brown, reddiſh.
3. *Cryſtalliſed ſparry Uranium* (Uranium ſpathoſum).
    - a. Tinged green by copper.
    - b. Yellow.

Extract from Meteorological Obſervations, made at Berlin in the Courſe of the Year 1787.

THE former part of theſe obſervations is given by Mr. de Beguelin, the latter by Mr. Achard, who has made conſiderable improvements on the uſual mode of obſerving. To the uſual daily obſervations of the changes in the barometer, thermometer, hygrometer, compaſs, anemometer, of the atmoſphere, and the phænomena in it, he has added thoſe of the hair hygrometer, invented by Sauſſure, of the quantity of rain or ſnow falling on a given ſurface, of daily evaporation, of the exact force of the wind, of its direction either upwards or downwards, and of the atmoſpherical electricity. They are made three times a day, morning, noon, and night. The tables are too extenſive to find a place in this work.

Firſt Memoir on the parallel Lines of Euclid. By M. de CASTILLON.

THIS author gives a decided preference to the ancient mathematicians, conceiving that the moderns, who have not walked in their ſteps, have all been guilty, from the uſe of algebra, of ſome paralogiſm, from which the ancients are exempt. He conceives, however, that the ancients are not entirely without fault; and the account of parallel lines given by Euclid is to be numbered among the defects of the chief geometer. The twenty-ninth propoſition of the firſt book is founded on this pretended axiom: If a right line, falling upon two other right lines, makes with them the two interiour angles on the ſame ſide leſs than two right angles, theſe two right lines being produced will meet on the ſide, where the two angles are leſs than two right angles. The literal meaning of the expreſſion "parallel lines" is right lines placed oppoſite to each other, *παρα αλληλαις*, whence it is certain, that the ancient mathematicians were either not much acquainted with metaphyſics, or did not chooſe to introduce them into geometry, which would indeed have been much injured by metaphyſical ſubtleties. The term "parallel lines" is more ancient than the time of Euclid, and the concluſion adopted by him from this term is placed in the number of definitions. Parallel right lines are thoſe which, being in the ſame plane, and produced to any length on either ſide, never meet. On this property Euclid built his doctrine of parallel lines, and his ſyſtem was not attacked till between two or three hundred years after, when Geminus treated his axiom above-mentioned with contempt *.

It is ridiculous, ſays Geminus, to put amongſt ſelf-evident propoſitions one, whoſe converſe is demonſtrable. The propoſition, if two right lines joined by a third make the interiour angles on the ſame ſide leſs than two right angles, theſe right lines will meet, has for its converſe, if two right lines meet, theſe two right lines, joined by a third, make the interiour angles leſs than two right angles. Now this laſt propoſition is demonſtrated by Euclid himſelf in the ſeventeenth propoſition of the firſt book, and therefore we muſt either remove his axiom or his ſeventeenth propoſition. This obſervation of Geminus is evidently well-founded; but we may aſk, is it probable that ſo exact a geometrician as Euclid ſhould have made uſe of ſuch an axiom, and that the error ſhould not have been perceived for above two hundred years? Is it not probable that the axiom is an interpolation?

Poſidonius changed the definition of Euclid, and made the fundamental property of parallel lines to conſiſt in the equality of perpendiculars, drawn between the lines †; but they might then with greater propriety have been called equidiſtant, and Euclid was certainly authoriſed in retaining the ancient name.

On the definition of Euclid, continues Geminus, its two parts agree with concentrical circles, which are in the ſame plane and do not meet. Theſe two properties of being in the ſame plane and not meeting belong to ſpirals deſcribed about right lines, and the ſpace between an hyperbola or a conchoid and a right line continually diminiſhes though the lines never meet. In this remark Geminus has fallen into an error; for Euclid is not ſpeaking of lines in general, but of right lines, *ευθειαι* not *γραμμαι*, and by this ſimple diſtinction the whole of the objection is at once removed.

Many other mathematicians have written upon the axiom and definition. The remaining part of the memoir is taken up with an hiſtorical account of ſeveral of them, particularly the Arabians; and the writer propoſes to give, in a ſecond memoir, the beſt demonſtrations he has found of the axiom, together with the demonſtration of Euclid, reſtored by his own conjecture.

On the ſecular Variations of the Elements of the Planet Herſchell, occaſioned by the Action of Saturn and Jupiter, and on the periodical Variations in its Motion, depending on its heliocentrical Diſtances from thoſe Planets. By M. Du Val Le Roi.

THE theory of ſecular and periodical variations, given in the laſt volumes of the Berlin Memoirs, by De la Grange, being the foundation of the calculations in this paper, and thoſe volumes not coming within the plan of this work, it was judged right to omit the abridgment of a paper, which is very long, and could not be well underſtood unleſs the volumes referred to were in the poſſeſſion of the reader.

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* Ramus, Schol. Math. lib. vii. pag. 159.

† Ibid. lib. vi. pag. 152, 153.

Obſervations on the Paſſage of Mercury over the Sun's Diſc on the 4th of May, 1786. By Profeſſor BEITLER, *of Mitaw, in Courland.*

AT day-break the profeſſor went into his obſervatory, and when the ſun's diſc was clearly above the horizon at 4h. 13′. 51″. true time, Mercury did not appear. At 16h. 35′. 27″. T. T. Mercury had in part entered. 37′. 26″. appeared to be the time of the interiour contact. During the paſſage there were ſeveral intervals when Mercury appeared ſufficiently diſtinct to admit the uſe of the micrometer, in which the diſtances of the neareſt edges of the Sun and Mercury were meaſured. At 22h. 1′. 3″. the interiour contact was apprehended to take place, and 22h. 4′. 32″. the planet quitted the ſun; but there was at the time a greater waving motion, and ſtronger black vapours over the ſun's diſc than at any other part of the obſervation.

The following table gives the calculations made on this ſubject. The column marked A, is that of De la Lande, and gives the mean time for Paris; B, that from the tables of Halley and Mayer, publiſhed under the direction of the Academy at Berlin. The time is the mean time at Berlin; and the difference of meridians between Paris and Berlin is ſuppoſed 44′ 25″. Parallax and aberration are neglected.

	A	B
Exteriour contact on entrance ——	14h. 17′. 19″	16h. 48′. 57″
Interiour contact on entrance ——	14. 21, 51	16. 53. 51
Inſtant of true conjunction ——	16. 26. 30	18. 45. 37
Geocentrick latitude of ☿ at this inſtant	11. 57,13	12. 37,81
Relative inclination of the orbit at this inſtant	10. 22. 30,7	10. 22. 58,6
Middle of the paſſage ——	16. 58. 32	19. 19. 33
Shorteſt diſtance of the centre ſeen from ♁	11. 45,41	12. 25,40
Interiour contact on departure ——	19. 35. 0	21. 44. 47
Exteriour contact on departure ——	19. 37. 18	21. 47. 16
Semidiameter of ☿ ſeen from the earth	6. 17	6. 17
Semidiameter of the ſun ——	15. 52,5	15. 53,9

There are two ſorts of conjunctions to be particularly diſcriminated: the apparent geocentrical conjunction affected by the aberrations of the ſun and Mercury, but not by the parallaxes; the other, the true geocentrical conjunction, when the centre of the planet is in the plane perpendicular to the ecliptick, paſſing through the centres of the ſun and earth; which is found by freeing the places found of the ſun and Mercury from the effect of the aberration of light.

The latitude of the obſervatory is 56°. 39′. 5″. its longitude 1h. 25′. 28″. eaſt of Paris, or 41′. 20″. eaſt of Berlin. The apparent geocentrical conjunction was at 18h. 48′. 36″. true time, at Mitaw; the apparent geocentrical latitude of Mercury at this inſtant 11°. 41″. the ſhorteſt geocentrical diſtance of the centres 11′. 29″,5. the middle of the paſſage 19h. 19′. 56″. Theſe were found from the nine beſt of twelve obſervations, made with a quadrant of a foot radius, in which Mercury appeared almoſt like a point. With the micrometer, in an equatorial achromatick inſtrument, made by Dollond, fifteen good obſervations were made, from which were deduced the ſhorteſt diſtance of the centres 11′. 29″,6. middle of the paſſage 19h. 19′. 9″. The difference of theſe obſervations from the preceding muſt be referred to the inevitable errours of obſervations, made either with the quadrant or the micrometer, in the diſadvantageous circumſtance related of the waving motion, and the black vapours paſſing over the ſun.

From theſe obſervations, with a ſmall correction, are calculated,

	″
The ſemi-diameter of ☿ ſeen from the earth	5,185
Diameter	10,37
Diameter ſeen from the ſun	12,836
Diameter ſeen at the mean diſtance of the ſun from the earth	5,79

Hence the apparent ſemi-diameter is made in the ſubſequent calculations 5″,18. and ſince the duration of the departure ought to be equal to that of the entrance, the apparent exteriour contact on entrance was 16h. 30′. 15″. mean time, or 16h. 33′. 42″. true time, of the meridian at Mitaw. Admitting the two exteriour contacts to be properly ſtated, and the ſemi-diameter of the ſun to be 15′. 49″,55 the following reſults will be had from four combinations.

Combination.	Of two Interiour Contacts.	Of two Exteriour Contacts.	Of Ext. Cont. on Entrance, with Inter. Cont. on Departure.	Of Int. Cont. on Entrance, with Exter. Cont. on Departure.
Mean time obſerved of Entrance	16h. 33′. 59″	16h. 30′. 15″	16h. 30′. 15″	16h. 33′. 59″
Mean time obſerved of Departure	21. 57. 34	22. 1. 18.	21. 57. 34.	22. 1. 18.
Duration by obſervation	5. 23. 35	5. 31. 3.	5. 27. 19.	5. 27. 19.
Shorteſt geocentrical diſtance	11. 28,53	11. 28,43	11. 28,49	11. 28,47
Mean time of the middle of the paſſage ſeen from the centre of the earth	19. 15. 59,68	19. 15. 59,91	19. 15. 59,00	19. 16. 0,59
Mean time of the apparent geocentrical conjunction	18h. 44′. 42″,93	18h. 44′. 43″,43	18h. 44′. 42″,36	18h. 44′. 44″,00
App. geoc. lat. at the time of app. geoc. conj.	11. 39, 98	11. 39,88	11. 39,94	11. 39,92
Equation of time at the above inſtant	3. 27, 8	3. 27,8	3. 27,8	3. 27,8
True time of the app. geoc conj. or affected by aberration	18h. 48′. 10″,7	18h. 48′. 11″,2	18h. 48′. 10″,2	18h. 48′. 11″,8

The parallaxes of diſtance employed were, for

			″
Contact	exteriour	of entrance	4,73
	interiour		4,73
Contact	interiour	of departure	3,15
	exteriour		3,10

The true time of the geocentrical conjunction deduced from theſe obſervations, which are the moſt exact, is within 3 ſeconds the ſame as the mean of the reſults drawn from obſervations made with the quadrant and micrometer, differing only 25″ from the firſt, and 31″ from the ſecond; and the ſhorteſt diſtances and latitudes at the time of the geocentrical conjunction are contained between two limits, differing only a ſingle ſecond.

From the reſult found by the obſervations of the contacts, and confirmed by the obſervations made with the inſtruments named, we may deduce the errour of the tables, and the place of the node. Suppoſing, then, the difference of time between Paris and Mitaw, 1h. 25′. 28″ and between Berlin and Mitaw 41′. 3″ we have,

	For Paris.	For Berlin.
Mean time of apparent geocentrical conjunction,	17h. 19′. 15″,3	18h. 3′. 23″,3
True time or affected by aberration	17. 22. 43	18. 6. 51
Apparent longitude of the ſun, or of Mercury, in apparent geocentrical conjunction	1s. 13°. 50′. 4″,8	1s. 13°. 50′. 14″,4
True hel. long. of Mercury } By the tables	7. 13. 54. 23, 1	7. 13. 46. 49, 0
True hel. lat. } By the tables	14. 1, 9	16. 16, 0
True geoc. long. } By the tables	1. 13. 46. 36, 4	1. 13. 53. 0, 2
True geoc. lat. by the tables	11. 19, 1	13. 7,98
Aberration in longitude	+ 7,02	+ 7,02
Aberration in latitude	+ 3,27	+ 3,27
App. geoc. long. by the tables	1. 13. 46. 43, 4	1. 13. 53. 7, 2
Obſerved long. in app. geoc. conj. affected by aberration	1. 13. 50. 4, 8	1. 13. 50. 14, 4
Errour of tables in geoc. long.	− 3. 21, 4	+ 2. 52, 8
Errour of tables in hel. long.	+ 4. 9, 6	− 3. 34, 0
Apparent geoc. lat. by the tables	11. 22, 4	13. 11,25
Apparent geoc. lat. by obſervation	11. 40, 0	11. 39,98
Errour of tables in lat. geoc.	− 17, 6	+ 1. 31, 3
Errour of tables in lat. hel.	− 21, 8	+ 1. 53, 0
Error of tables from the hor. geoc. motion referred to the ecliptic = 3′. 57″. 904	− 50′. 47″,6	+ 43′. 35″,0
Mean time of contact ext. } entrance	15h. 6′. 29″,7	15h. 50′. 37″,7
Mean time of contact int. } entrance	15. 10. 13, 5	15. 54. 21, 5
Mean time of contact int. } departure	20. 30. 57, 5	21. 15. 5, 5
Mean time of contact ext. } departure	20. 34. 41, 7	21. 18. 49, 7
affected by aberration, and ſeen from the centre of the ſun.		
Duration of entrance or departure ſeen from centre of the earth	3′. 44″,2	3′. 44″,2
Interval between the two exter. contacts, ſeen from the centre of the earth	5h. 28′. 12″	5h. 28′. 12″
Interval between the two inter. contacts, ſeen from the centre of the earth	5. 20. 44	5. 20. 44
Effect of parallax for Mitaw, on the time of contact, Entrance = − 1′. 42″½ Departure = + 1. 8½		
True long. of the ſun freed from aberration at inſtant of app. geoc. conjunction	1s. 13°. 50′. 24″,8	1s. 13°. 50′. 34″,4
Obſerved geoc. long. of Mercury at the above inſtant, freed from aberration	1. 13. 49. 57, 8	1. 13. 50. 7, 4
Difference of the two true geoc. long.	27, 0	27, 0

	For Paris.	For Berlin.
True geoc. conj. precedes the app. geoc. conj. by	6′. 48″,6	6′. 48″,6
Mean time of true geoc. conj. freed from aberration	17h. 12′. 26″,7	17h. 56′. 34″,7
Obſerved geoc. lat. of Mercury at the time of app. geoc. conj. freed from aberration ———	11′. 36″,73	11′. 36,71
Change of lat. in 6′. 48″,6 at the rate of 43″,557 an hour	4,94	4,94
True geoc. lat. at the inſtant of true geoc. conj.	11. 41,67	11. 41,65
True hel. lat. at the above inſtant ———	14. 29,46	14. 29,05
Inclination of the orbit ———	7°. 0′. 0″	6°. 59′. 20″,0
Diſtance of Mercury from the node, reckoned upon the ecliptic, at the inſtant of true geoc. conj. ——	1°. 58′. 2″,6	1°. 58′. 10″,8
Motion of the ſun in 6′. 48″,6 ———	16, 5	16, 5
True long. of the ſun, free from aberration, and corrected by theſe 16″,5 at the inſtant of true geoc. conj.	1s. 13°. 50′. 8″,3	1s. 13°. 50′. 17″,9
True hel. long. of Mercury at the above inſtant, free from aberration ——— ———	1s. 13°. 50′. 8″,3	1s. 13°. 50′. 17″,9
Long. of the node, found by obſervation ——	7. 15. 48. 10, 9	7. 15. 48. 28, 7
Long. of the node, given by the tables ——	7. 15. 48. 30, 0	7. 15. 59. 15, 9
Difference	+ 19, 1	+ 10. 47, 2

In the column for Paris the tables of the ſun, the place of the aphelion, and the eccentricity of the orbit of Mercury, given by De la Lande, in his Aſtronomy, are employed. In the column for Berlin, the ſolar tables of Mayer are uſed, correcting the times of 17″, and ſuppoſing the place of the aphelion and eccentricity of Mercury ſuch as are given by Halley's tables.

Eſſay on the True Elliptical and Parabolic Horary Motion. By Mr. BEITLER.

THEOREM.

LET $v =$ the true anomaly of a planet or comet in a given inſtant; $m =$ any time expreſſed in mean ſolar hours, and their decimal parts. S or s, according as the time m is before or after the given inſtant, $=$ the arc of true anomaly deſcribed in m hours. $\Delta v =$ the horary change of true anomaly, if the body was to move uniformly for an hour with the ſame velocity which it has at the inſtant when its true anomaly $= v$. $\Delta^2 v$ is the horary variation of this motion. $\Delta^3 v$, $\Delta^4 v$, $\Delta^5 v$, &c. ſucceſſive variations. Let H be the horary motion after m hours, and h that which took place m hours before, then

$$S = m\Delta v + m^2 . \frac{\Delta^2 v}{1.2} + m^3 \frac{\Delta^3 v}{1.2.3} + m^4 \frac{\Delta^4 v}{1.2.3.4} + \ldots . + m^k \frac{\Delta^k v}{1.2\ldots(k-1).k}$$

$s = m$.

$$\text{ſ} = m.\,\Delta v - m^2\,\frac{\Delta^2 v}{1.\,2} + m^3.\,\frac{\Delta^3 v}{1.\,2.\,3} - m\,.\,\frac{\Delta^4 v}{1.\,2.\,3.\,4} + \ldots.$$

$$- m^{2k}\,\frac{\Delta^{2k} v}{1.\,2\ldots 2k - 1.\,2.\,k}$$

$$S - \text{ſ} = 2\left[m^2\,\frac{\Delta^2 v}{1.\,2} + m^4\,\frac{\Delta^4 v}{1.\,2.\,3.\,4} + m^6\,.\,\frac{\Delta^6 v}{1.\,2.\,\ldots 5.\,6} + \ldots. \right.$$

$$\left. + m^{2k}\,\frac{\Delta^{2k} v}{1.\,2\ldots 2k - 1.\,2k} \right]$$

$$S + \text{ſ} = 2\left[m\,\Delta v + m^3\,\frac{\Delta^3 v}{1.\,2.\,3} + m^5\,\frac{\Delta^5 v}{1.\,2.\,3.\,4.\,5} + \ldots. \right.$$

$$\left. + m^{2k+1}\,\frac{\Delta^{2k+1} v}{1.\,2\ldots 2k.\,2k+1} \right]$$

$$H = \Delta v + m\Delta^2 v + m^2\,\frac{\Delta^3 v}{1.\,2} + m^3\,\frac{\Delta^4 v}{1.\,2.\,3} + \ldots.$$

$$+ m^k\,\frac{\Delta^{k+1} v}{1.\,2\ldots k - 1.\,k}$$

$$h = \Delta v - m\Delta^2 v + m^2\,\frac{\Delta^3 v}{1.\,2} - m^3\,\frac{\Delta^4 v}{1.\,2.\,3} + m^4\,\frac{\Delta^5 v}{1.\,2.\,3.\,4}\ldots.$$

$$- m^{2k-1}\,\frac{\Delta^{2k} v}{1.\,2\ldots k - 1.\,k}\ldots.$$

$$H + h = 2\left[\Delta v + m^2\,\frac{\Delta^3 v}{1.\,2} + m^4\,\frac{\Delta^5 v}{1.\,2.\,3.\,4} + m^6\,\frac{\Delta^7 v}{1.\,2\ldots 6} + \ldots. \right.$$

$$\left. m^{2k}\,\frac{\Delta^{2k+1} v}{1.\,2\ldots 2k - 1.\,2k} + \ldots. \right]$$

$$H - h = 2\left[m\Delta^2 v + m^3\,\frac{\Delta^4 v}{1.\,2.\,3} + m^5\,\frac{\Delta^6 v}{1.\,2.\,3.\,4.\,5} + \ldots. \right.$$

$$\left. m^{2k-1}\,\frac{\Delta^{2k} v}{1.\,2.\,3\ldots 2k-2.\,2k-1} + \ldots. \right]$$

In general $\Delta^n v$ is changed in the m hours $\left.\begin{matrix}\text{before}\\ \text{after}\end{matrix}\right\}$ the epocha into

$$\Delta_n v \pm m\,\Delta^{n+1} v + m^2\,\frac{\Delta^{n+2} v}{1.\,2} \pm m^3\,\frac{\Delta^{n+3} v}{1.\,2.\,3} + \ldots.$$

The arc which the body really deſcribes in an hour by its accelerated or retarded motion is to be diſtinguiſhed from Δv, H, h. For being called δv

$$\delta v = \Delta v \pm \frac{\Delta^2 v}{1.\,2} + \frac{\Delta^3 v}{1.\,2.\,3} \pm \frac{\Delta^4 v}{1.\,2.\,3.\,4} + \ldots.$$

the ſigns above referring to the ſucceeding; thoſe below to the preceding hour.

Theſe formulas are corollaries from Euler's general theorem in his Inſtitutiones Calculi Differentialis, Pars poſterior, Cap. III. To apply them to the parabolic motion, let $1 : \pi$ be the ratio of the diameter to the circumference of a circle, ρ an arc equal to the radius expreſſed in ſeconds. Sidereal year = 365,25637 days, expreſſed in mean ſolar hours = t; perihelion diſtance of the comet = p. By a calculation from the formulas giving the fluxional expreſſions for the true and mean anomaly in the parabola, we find $\Delta\, v = \frac{2\sqrt{2}\,.\,\pi\varrho\,.\,\text{coſ.}\,\frac{1}{2}v^4}{t\,p\sqrt{p}}$

Let $\frac{2\sqrt{2}\,\pi\varrho}{t} = N$, then $\Delta\, v = \frac{N.\,\text{coſ.}\,\frac{1}{2}v^4}{p^{\frac{3}{2}}}$

Let T be the number of mean ſolar hours in going from the perihelion to 90°, true anomaly, then $\Delta v = \frac{8\,\varrho\,\text{coſ.}\,\frac{1}{2}v^4}{3.\,T.}$

Let $\frac{N}{\varrho} = n$ and $\frac{n}{p^{\frac{3}{2}}} = \alpha$, and dv, d^2v, d^3v, &c. ſignify the ſame quantities as Δv, $\Delta^2 v$, $\Delta^3 v$, only in decimal parts of the radius, and not in ſeconds of a degree, ſo that $dv = \frac{\Delta v}{\varrho}$, $d^2v = \frac{\Delta^2 v}{\varrho}$, $d^3v = \frac{\Delta^3 v}{\varrho}$, then $dv = \alpha\ \text{coſ}\ \frac{1}{2}v^4$, $d^2v = -2\ \text{tang.}\ \frac{1}{2}v\,dv^2$, and ſince $\text{coſ}\,\frac{1}{2}v^2 = \frac{dv^{\frac{1}{2}}}{\alpha^{\frac{1}{2}}}$, and $\text{tang.}\ \frac{1}{2}v = -\frac{ddv}{2\,dv^2}$ we have,

$$d^3v = 2\,dv^{-1}\,d^2v^2 - \alpha^{\frac{1}{2}}\,dv^{\frac{5}{2}}$$
$$d^4v = 6\,dv^{-2}\,d^2v^3 - \frac{13}{2}\alpha^{\frac{1}{2}}\,dv^{\frac{3}{2}}\,d^2v$$
$$d^5v = 24\,dv^{-3}\,d^2v^4 - \frac{163}{4}\alpha^{\frac{1}{2}}\,dv^{\frac{1}{2}}\,d^2v^2 + \frac{13}{2}\alpha\,dv^4$$
$$d^6v = 120\,dv^{-4}\,d^2v^5 - \frac{2235}{8}\alpha^{\frac{1}{2}}\,dv^{-\frac{1}{2}}\,d^2v^3 + \frac{215}{2}\alpha\,dv^3\,d^2v.$$

When $v = 0$, or in reckoning from the inſtant of paſſage by the perihelion, d^2v, d^4v; and in general $d^{2n}v = 0$, and the true anomaly is expreſſed by the ſeries

$$S = m\,\Delta v + m^3.\,\frac{\Delta^3 v}{1.\,2.\,3} + m^5\,.\,\frac{\Delta^5 v}{1.\,2.\,3.\,4.\,5}\ .\ .\ .\ .$$
$$+\,m^{2k+1}\,\frac{\Delta^{2k+1}v}{1.\,2.\,3\ldots\,2k+1}\ .\ .\ .\ .$$

and for the horary motion m hours before or after the paſſage by the perihelion,

$$\text{H} = \Delta v + m^2\,\frac{\Delta^3 v}{1.\,2} + m^4\,.\,\frac{\Delta^5 v}{1.\,2.\,3.\,4.}\ .\ .\ .\ .$$
$$+\,m^{2k}\,\frac{\Delta^{2k+1}v}{1.\,2.\,3\ldots\,2k-1.\,2k}\ .\ .\ .\ .$$

In this caſe,

$$dv = \frac{2\sqrt{2}\,.\,\pi\varrho}{tp\sqrt{p}} = \alpha = \text{velocity in the perihelion}$$
$$d^3v = -\alpha^{\frac{1}{2}}\,dv^{\frac{5}{2}} = -\alpha^3$$
$$d^5v = +\frac{13}{2}\alpha\,dv^4 = +\frac{13}{2}\alpha^5$$
$$d^7v = -\frac{215}{2}\alpha^{\frac{3}{2}}\,dv^{\frac{11}{2}} = -\frac{215}{2}\alpha^7.\ \text{\&c. \&c.}$$

For the motion of planets in an ellipſe, let dY = horary motion in mean anomaly, expreſſed in ſeconds, a = diſtance of aphelion, p = diſtance of perihelion, A = major axis, c = minor axis, e = eccentricity, all decimal parts of the mean diſtance of the earth from the ſun = 1.

Making $\mathrm{N} = \frac{\mathrm{A}^3 \pi \varrho \, d \Upsilon}{1296000 \, \alpha^{\frac{1}{2}} \, p^{\frac{3}{2}}}$ and $\frac{2e}{\mathrm{A}} = \text{coſ}\, v - \text{coſ}\, x$, the following forms will be found for the horary motion in true anomaly.

1. Reckoning the true anomaly from the aphelion,

$$\Delta v = \frac{\mathrm{N}}{4} (1 - e \,\text{coſ}\, v)^2 = \mathrm{N} \,\text{ſin}\, \tfrac{1}{2} x^4$$

2. Beginning the true anomaly in the perihelion,

$$\Delta v = \mathrm{N} \,\text{coſ}\, \tfrac{1}{2} x^4$$

By expreſſing the elements of the elliptick orbit in decimal parts of the mean diſtance $= 1$, and introducing the minor axis,

$$\mathrm{N} = \frac{\pi \varrho \, d \mathrm{Y}}{162000 \, \alpha^{\frac{1}{2}} \, p^{\frac{1}{2}}} = \frac{\pi \varrho \, d \mathrm{Y}}{20205 \, c^3}, \text{ and coſ } x = e \,\text{coſ}\, v. \quad \text{Putting now } \frac{\mathrm{N}}{\varrho} = n,$$

$$d^2 v = e n^{\frac{1}{2}} \,\text{ſin}\, v \, dv^{\frac{3}{2}}$$

$$d^3 v = \frac{e n^{\frac{1}{2}}}{d v^{\frac{1}{2}}} [\text{coſ}\, v \, dv^3 + \tfrac{3}{2} \,\text{ſin}\, v \, dv \, d^2 v]$$

$$\frac{e n^{\frac{1}{2}}}{d v^{\frac{1}{2}}} \,\text{coſ}\, v \, [dv^3 + \tfrac{3}{2} \text{ tang. } v : dv \, d^2 v] = \frac{e n^{\frac{1}{2}}}{d v^{\frac{1}{2}}} \,\text{coſ}\, v \, f$$

$$d^4 v = \frac{e n^{\frac{1}{2}}}{d v^{\frac{1}{2}}} [4 \,\text{coſ}\, v \, dv^2 \, d^2 v + \text{ſin}\, v \, [\tfrac{3}{4} d^2 v^2 + \tfrac{3}{2} dv \, d^3 v - dv^4]$$

$$= \frac{e n^{\frac{1}{2}}}{d v^{\frac{1}{2}}} \,\text{ſin}\, v \, [\tfrac{3}{4} d^2 v^2 + \tfrac{3}{2} dv \, d^3 v - dv^4 + 4 \text{ cot. } v \, d^2 v \, dv^2]$$

$$= \frac{e n^{\frac{1}{2}}}{d v^{\frac{1}{2}}} \,\text{ſin}\, v \, \varphi. \text{ \&c. \&c.}$$

By reckoning from the inſtant that the planet is in the aphelion or perihelion, theſe expreſſions are ſimplified, ſince the fluxions of an even order diſappear, or $d^2 v = d^4 v = d^{24} v = 0$, and

$$d^3 v = \pm e n^{\frac{1}{2}} dv^{\frac{5}{2}}$$

$$d^5 v = \pm e n^{\frac{1}{2}} dv^{\frac{3}{2}} [\tfrac{11}{2} d^3 v - dv^3]$$

$$d^7 v = \pm \frac{e n^{\frac{1}{2}}}{d v^{\frac{1}{2}}} \left[\frac{17}{v} dv^2 \, d^5 v + \frac{105}{4} dv \, d^3 v^2 - 25 \, dv^4 \, d^3 v + dv^7\right].$$

The ſign + is uſed when the departure is taken from the aphelion, and — when from the perihelion. The general expreſſions for S, s, H, h, δv, and the value of $\Delta^n v$, before or after m hours, are the ſame as in a parabolick motion.

By this method the tranſit of Mercury over the ſun, deſcribed in the laſt paper, was calculated; and examples are given, in which it is applied to the motion both of planets and comets in their orbits.

General

General Conſiderations on the Situation of the Orbits of all the Planets and Comets which have hitherto been calculated. By Mr. BODE.

THERE are only ſeventy-two comets, whoſe orbits, from the accounts given of them between the years 837 and 1785, can be traced by aſtronomers. Of theſe we can depend only on two between the years 837 and 1231, on eight for the three following centuries, ten in the next century, and the remaining fifty-two have been obſerved carefully ſince the year 1652. It is the purport of this paper to determine in what the orbits of theſe comets as well as of the planets agree as to diſtribution, direction, inclination, and other circumſtances, deriving ſome probable reſults from the different poſition of theſe orbits to the axis of the ſun and its equator, and the different ſituation of their perihelia and nodes.

The heliocentrick places of the perihelia of the ſeven planets lie between the ſecond degree of piſces and the ſeventeenth degree of virgo, in an arc of 195°. The perihelia of the greater part of the ſeventy-two comets lie within the ſame ſpace, forty-three being within the ſame ſigns, and taking in the latter degrees of aquarius, we ſhall have forty-ſix in that ſpace, the other twenty-ſix being in the four remaining ſigns, and the firſt half of aquarius. In aries there are 4, taurus 7, gemini 6, cancer 11, leo 8, virgo 4, libra 3, ſcorpio 5, ſagittarius 9, capricornus 5, aquarius 7, piſces 3. There being in the northern ſigns 40, in the ſouthern ſigns 32. We find that the axis of the ſun is inclined at an angle of 82½, the northern pole being in that latitude north, in the 8th of piſces, and the ſouthern pole in the ſame latitude ſouth, in the 8th of virgo. In the neighbourhood of each pole there is only one perihelion, and in the two ſigns piſces and virgo only ſeven; but in the ſigns gemini and ſagittarius, in which are the places of the ſolar equatorial nodes, fall a much greater number of perihelia. From this we might be led to conclude, that the poſition of the ſolar axis has an influence on the approximation of the comets, and that this approximation is moſt frequently made according to the perpendicular to this axis. We might extend this obſervation to the planetary orbits; for, when we are looking at the ſun in piſces, the perihelia of the planets lie almoſt all to the eaſt of the ſolar axis, and the aphelia to the weſt.

For the diſtance of theſe comets from the ſun in their perihelia we may obſerve, that between the ſun and the orbit of Mercury have paſſed 15; between the orbits of Mercury and Venus 32; between the orbits of Venus and the earth 13; between the orbits of the earth and Mars 8; between the orbits of Mars and Jupiter 4. The greater number has been nearer to the ſun than our earth is; and we may conclude, that they ought to be more frequently viſible to the inhabitants of the earth than the more diſtant ones, becauſe, their velocity being greater, their returns are more frequent, and they retain the light derived from the ſun, ſo as to remain a longer time viſible. There are more comets alſo paſſing between the orbits of Venus and Mercury than between any other two orbits, which may be accounted for in this manner. Theſe comets paſs within half the diſtance of the earth from the ſun, and are therefore ſome months in going round the ſun, whence they may be ſeen the more eaſily from the earth, either on the eaſtern or the weſtern ſide; they reflect more ſtrongly the ſolar light, than the more diſtant comets; they are ſeen under a greater viſual angle, and they have a tail in general of greater extent. The comets between the Earth and Venus, or at a greater diſtance, are too weakly illumined, and have tails too ſmall to be ſeen; beſides, their apparent motion, when near the earth, being very great, they paſs through large arcs in a ſhort time; and, their diameters conſtantly diminiſhing, they are ſoon inviſible. Of the ſeventy-two comets only twelve do not come within the orbit of the earth, and yet the ſpace without that orbit is by far the greateſt. In all probability that ſpace has received as many comets as can exiſt in it. Lambert, in his coſmological letters, determines, that the number of comets ought to increaſe in the duplicate ratio of the diſtances of their perihelia; and, according to this principle, he places two million comets in the orbit of Saturn. This poſition is confirmed by Halley's Tables of comets, which give 17 perihelia beyond the orbit of Venus, for ſix beyond the orbit of Mercury. Now 17 : 6 : : 3 : 1 nearly, that is as the ſquares of the diſtances of theſe two planets. The ſame reſult follows from the account given above, which places 47 perihelia between the Sun and Venus, and 15 between the Sun and Mercury. Now 47 : 15 : : 3 : 1 nearly.

It appears that, in the paſſage round the ſun, thirty comets have been ſeen between April and September, and forty-two between October and March. This may be accounted for from our ſeeing the comets, when they approach the perihelia only in the night, and, if we had a more circumſtantial account, it is probable, that the number of thoſe ſeen in the winter months would be to that of thoſe in the ſummer months exactly in the proportion of the length of the nights.

The aſcending nodes of all the planetary orbits are towards the ſame part as their perihelia, that is, between the 16th degree of taurus and the 21ſt of cancer, and in this ſpace are the aſcending nodes of twenty-eight of the comets. Between the 19th of piſces and the 19th of virgo are the aſcending nodes of forty-five comets, ſo that the major part of the orbits of the comets and the orbits of all the planets are ſimilarly directed in the ſolar ſyſtem, and ſimilarly inclined to the plane of the earth's orbit. In aries are the aſcending nodes of 9 comets; in taurus 7; in gemini 12; in cancer 2; in leo 8; in virgo 7; in libra 5; in ſcorpio 6; in ſagittarius 5; in capricornus 4; in aquarius 4; in piſces 3. Thus, there are forty-five in the northern ſigns, and twenty-ſeven in the ſouthern ſigns.

The greater part of the comets have, like all the planets except Herſchell, their perihelia neareſt to the aſcending nodes. The perihelia of forty were within 90° of the aſcending node, of two exactly between the two nodes, and of the remaining thirty nearer the deſcending node, but not ſo near to that node as the others were to the aſcending node.

Eight only of the ſeventy-two comets have the plane of their orbit leſs inclined to the eclipticK than the orbits of the planets. The inclinations are as follows: Under 10 degrees, eight comets; between 10° and 20°, eight; between 20° and 30°, four; between 30° and 40°, nine; between 40° and 50°, five; between 50° and 60°, nine; between 60° and 70°, eleven; between 70° and 80°, nine; between 80° and 90°, nine. It does not appear, that the inclinations are greater or leſs at any particular quarter: they are all equally poſſible; and thus, by the wiſdom of the Supreme Being, the ſyſtem of the world is better filled, and the planets and comets are leſs in danger of interfering with each other. Neither do the perihelia ſeem to be diſpoſed in different quarters, according to the greater or leſs inclination, nor have the different obliquities any relation to the diſtances of the comets from the ſun. Thirteen indeed of thoſe, which traverſe the orbit of mercury, have their orbits inclined between 30 and 80 degrees, which may have been done to render them leſs liable to encounter with the inferiour planets. To ſhew the equal poſſibility of all the angles of obliquity of the orbits of the comets, in the following table, the number of comets anſwering to each inclination, taken from 10° to 10°, is compared with the number of thoſe, which would agree with the ſame inclinations, if we were to ſuppoſe them uniformly arranged.

Obliquity of the orbits.	Number of comets obſerved.	Number given by calculation.	Difference.
10°	8	8	— 0
20°	16	16	— 0
30°	20	24	+ 4
40°	29	32	+ 3
50°	34	40	+ 6
60°	43	48	+ 5
70°	54	56	+ 2
80°	63	64	+ 1
90°	72	72	0

Thirty-eight of the comets move from weſt to eaſt, thirty-four in the contrary direction; but there is no relation between theſe directions with the inclination of the orbits, and the ſituation of the nodes or the perihelia. Of the nine comets, whoſe orbits are leſs inclined to the plane of the eclíptick than thoſe of the planets, ſeven move in the ſame direction with the planets: the thirty-four retrograde comets have their perihelia in nine ſigns, none being in piſces, virgo or libra; and in the two ſigns piſces and virgo, are the poles of the ſun. Their aſcending nodes are not in piſces, nor thoſe of the other comets in cancer.

Forty-three comets move towards the ſun, when they have paſſed the aſcending, and twenty-nine, when they have paſſed the deſcending node. The former have their perihelia in the northern, the latter in the ſouthern hemiſphere. Thus the perihelia of the comets are diſpoſed with ſufficient equality in both hemiſpheres; but we may infer, that the moſt favourable circumſtances for ſeeing a comet are combined in that part of his orbit between the nodes, and that in which is its perihelion. The greater the angle of inclination of the comets, whoſe perihelia are in the ſouth, and the leſs elevated they are above our horizon, the leſs viſible are they to us; whilſt the greater is this angle of thoſe in the northern hemiſphere, the more viſible are they to us.

When the comets, whoſe motion is direct, have their aſcending nodes more to the weſt than their perihelia, the latter have a northern latitude: if the deſcending nodes are more to the weſt, the latitude of the perihelion is ſouthern. The contrary takes place in the retrograde comets. Fifteen of the retrograde comets had their perihelia in a ſouthern latitude, and nineteen in a northern. Twenty-four of the direct were northern, fourteen ſouthern. When the perihelion is in the northern hemiſphere, the obliquity is very conſiderable as far as 89°; in the ſouthern hemiſphere the greateſt obliquity is 79°.

That the perihelia might be uniformly diſtributed in the ſphere, their heliocentrick latitude ſhould increaſe like the zones of the ſphere, that is, as the ſines of the latitudes. The following table gives the correſpondence of the comets obſerved with ſuch a calculation.

Latitude of the perihelion.	Number of comets obſerved.	Number given by calculation.	Difference.
10°	16	12	— 4
20	29	24	— 5
30	41	36	— 5
40	49	46	— 3
50	55	55	0
60	61	62	+ 1
70	68	68	0
80	71	71	0
90	72	72	0

Thus all the angles of inclination are equally poſſible, and the perihelia are diſpoſed with ſufficient uniformity; we may now enquire whether in fact the orbits have every poſſible ſituation.

The ſituation of the orbit is determined by drawing from the ſun a perpendicular to its plane, and where it pierces the heavens, is the pole of the orbit. To give the orbits every poſſible ſituation, theſe poles muſt be diſpoſed uniformly in the heavens, and the number of orbits muſt increaſe, as the ſines of the complement of the elevation of this pole above the ecliptick. Taking theſe complements for every ten degrees of the ſines, from the greateſt ſine = 72 the number of our comets, we have this table.

Latitudes of the perihelia.	Number of comets obſerved.	Number given by calculation.	Difference.
10°	9	12	+ 3
20	18	24	+ 6
30	29	36	+ 7
40	38	46	+ 8
50	43	55	+ 12
60	52	62	+ 10
70	56	68	+ 12
80	64	71	+ 7
90	72	72	0

Hence it appears that the poles of their orbits are not uniformly diſpoſed over the firmament.

From what has been ſaid, there appear in the motion of the comets traces of order and regularity, that they cannot be left at random. They are not bodies wandering without law in the wide expanſe, but their orbits are marked out for wiſe and beneficent purpoſes, by the Governor of the univerſe.

Suppoſing the diſtance of the ſun from the earth 1000, three of the comets can approach as near to the earth as 2, 6, and 9 of thoſe parts, twelve may be between 10 and

50,

50, and 11 between 50 and 100. There are only two, however, which paſs at a greater diſtance than 1000, one at 1446, the other at 3072. Hence we may eſtimate the danger to the earth from any one of the comets.

In the following table are ſeen, at one view, the chief circumſtances relating to the comets that have been as yet obſerved.

No.	Perihelion.			Longitude. Aſc. node.			Incl. orb.		Perihelion. In the orbit.			Perihelion. In the ecliptick.			Lat. of perihel.		Diſtance of perihel.	Motion
	Year.	M.	D.	S.	D.	M.	D.	M.	S.	D.	M.	S.	D.	M	D.	M.	♁ from ☉=1000	
	Old ſtyle.																	
1	837	March	1	♎	26	33	11	—	♑	19	3	♑	18	55	10	54 A.	580	r
2	1231	Jan.	30	♈	13	30	6	5	♌	14	48	♌	14	58	5	11 B.	948	d
* 3	1264	July	17	♍	28	45	30	25	♑	5	45	♑	6	51	30	10 B.	411	d
4	1299	March	31	♋	17	8	68	57	♈	3	20	♓	12	46	65	0 B.	318	r
5	1301	Oct.	22	♈	15	—	70	—	♑	15	—	♑	15	—	70	— B.	450	r
6	1337	June	2	♊	24	21	32	11	♉	7	59	♉	12	45	22	40 B.	407	r
* 7	1456	June	8	♉	18	30	17	56	♒	1	0	♒	0	10	17	5 B.	585	r
8	1472	March	1	♑	11	46	5	20	♉	15	33	♉	15	40	4	26 A.	543	r
* 9	1532	Oct.	20	♊	20	27	32	36	♋	21	7	♋	17	0	15	17 B.	509	d
10	1533	June	17	♌	5	44	35	49	♌	27	16	♌	23	27	12	23 A.	203	r
11	1577	Oct.	27	♈	25	52	74	33	♌	9	22	♍	7	53	69	35 A.	183	r
12	1580	Nov.	28	♈	18	57	64	40	♋	19	6	♋	19	17	64	40 B.	596	d
13	1582	May	7	♏	21	7	61	28	♐	5	23	♏	28	2	12	30 A.	225	r
	New ſtyle.																	
14	1585	Oct.	8	♉	7	42	6	4	♈	8	51	♈	8	59	2	55 A.	1093	d
15	1590	Feb.	8	♍	15	30	29	41	♏	6	54	♏	2	56	22	46 A.	577	r
16	1593	July	19	♍	14	15	87	58	♍	26	19	♍	14	41	12	3 B.	89	d
17	1596	Auguſt	9	♒	15	37	52	10	♏	28	31	♐	6	6	50	21 B.	549	r
18	1618	Auguſt	17	♑	23	25	21	28	♒	18	20	♒	16	48	8	52 B.	513	d
19	1618	Nov.	8	♊	16	1	37	34	♈	2	14	♈	6	10	35	50 A.	380	d
20	1652	Nov.	13	♊	28	10	79	28	♈	28	19	♊	10	42	58	14 A.	847	d
21	1664	Dec.	4	♊	21	14	21	18	♌	10	41	♌	8	41	16	2 A.	1026	r
22	1665	April	24	♏	18	2	76	5	♊	11	54	♉	24	7	23	8 B.	106	r
23	1672	March	1	♑	27	30	83	22	♉	16	59	♋	9	26	69	28 B.	697	d
24	1677	May	6	♏	26	49	79	3	♌	17	37	♋	16	21	75	44 B.	280	r
25	1678	Auguſt	27	♍	11	40	3	4	♒	27	46	♒	27	47	0	44 B.	1238	d
26	1680	Dec.	18	♑	2	2	60	56	♐	22	39	♐	27	27	8	12 A.	6	d
27	1683	July	13	♍	23	23	83	11	♊	25	29	♋	10	37	82	52 B.	560	r
28	1684	June	8	♐	28	15	65	49	♏	28	52	♐	15	15	26	35 A.	960	d
29	1686	Sept.	17	♓	20	35	31	22	♊	17	0	♊	16	24	31	18 B.	325	d
30	1689	Dec.	1	♒	23	45	69	17	♐	23	45	♑	22	15	54	6 B.	17	r
31	1698	Oct.	19	♐	27	44	11	46	♑	0	51	♑	0	47	0	38 A.	691	r
32	1699	Jan.	13	♒	21	46	69	20	♏	2	31	♎	7	4	62	3 B.	744	r
33	1702	March	14	♎	9	25	4	30	♌	18	41	♌	18	46	3	29 A.	646	d
34	1706	Jan.	30	♈	13	11	55	14	♊	12	29	♉	27	1	44	56 B.	426	d
35	1707	Dec.	12	♉	22	47	88	36	♊	19	55	♉	23	29	27	8 B.	860	d

No.	Perihelion.			Longitude. Aſc. node.			Incl. orbit.		Perihelion. In the orbit.			Perihelion. In the ecliptick.			Lat. of perihel.			Diſtance of perihel.	Motion
	Year	M.	D.	S.	D.	M.	D.	M.	S.	D.	M.	S.	D.	M.	D.	M.		♁ from ☉=1000	
36	1718	Jan.	15	♌	8	43	30	20	♌	1	30	♌	2	29	3	38	B.	1026	r
37	1723	Sept.	28	♈	14	16	49	59	♉	12	52	♉	3	35	21	30	A.	998	r
38	1729	May	22	♒	10	52	77	19	♒	16	27	♒	12	5	5	28	B.	3711	d
39	1737	Jan.	30	♏	16	22	18	21	♒	25	55	♒	25	11	4	42	B.	223	d
40	1739	June	17	♎	27	25	55	43	♋	12	39	♋	2	20	53	2	B.	673	r
41	1742	Feb.	8	♎	5	38	66	59	♏	7	35	♎	19	20	29	9	A.	766	r
42	1743	Jan.	11	♊	8	11	2	16	♋	2	58	♋	2	57	0	57	B.	838	d
43	1743	Sept.	21	♈	5	16	45	48	♐	6	34	♏	28	7	38	58	B.	520	r
44	1744	March	1	♉	15	46	47	5	♎	17	10	♎	25	24	20	31	B.	222	d
45	1747	March	3	♌	27	19	79	6	♑	7	2	♒	14	29	49	3	A.	2198	r
46	1748	April	29	♏	22	52	85	27	♏	5	1	♏	21	24	17	48	B.	841	r
47	1748	June	18	♉	4	40	56	59	♑	6	9	♐	19	45	47	28	A.	655	d
48	1757	Oct.	21	♏	4	6	12	39	♌	2	39	♌	2	37	12	39	A.	339	d
49	1758	June	11	♏	20	50	68	19	♐	27	38	♐	6	17	33	50	B.	215	d
50	1759	Nov.	27	♌	19	39	78	59	♉	23	24	♊	8	28	78	22	B.	798	d
51	1759	Dec.	17	♊	19	51	4	51	♌	18	24	♌	18	18	4	8	A.	966	r
52	1762	May	28	♓	19	2	85	3	♋	14	30	♍	8	46	64	5	B.	1010	d
53	1763	Nov.	2	♓	26	29	73	39	♊	25	1	♊	21	17	73	35	B.	498	d
54	1764	Feb.	12	♋	19	20	53	54	♈	16	12	♈	14	1	53	47	B.	564	r
55	1766	Feb.	17	♐	4	11	40	50	♌	23	15	♌	19	52	39	56	B.	505	r
56	1766	April	17	♊	14	22	11	8	♐	2	18	♐	2	31	2	19	B.	333	d
57	1769	Oct.	7	♍	25	1	40	38	♌	24	6	♍	0	44	19	31	A.	123	d
58	1770	Aug.	9	♌	19	39	1	44	♓	25	27	♓	25	26	1	1	A.	637	d
59	1770	Nov.	23	♋	18	42	31	26	♎	28	23	♏	0	0	30	56	A.	528	r
60	1771	April	19	♈	27	51	11	15	♋	13	28	♋	13	32	10	57	B.	906	d
61	1772	Feb.	19	♐	12	43	19	0	♋	18	6	♋	16	36	10	52	A.	1018	d
62	1773	Sept.	12	♌	1	16	61	25	♊	15	36	♋	5	11	38	55	A.	1134	d
63	1774	Aug.	15	♎	0	46	83	0	♒	17	22	♓	24	12	43	0	B.	1429	d
64	1779	Jan.	4	♈	25	6	32	24	♊	27	13	♊	23	2	28	16	B.	713	d
65	1780	Oct.	1	♌	4	9	53	48	♐	6	21	♐	20	59	43	4	A.	99	r
66	1781	July	7	♊	23	1	81	43	♏	29	11	♐	19	23	23	34	B.	776	d
67	1781	Nov.	29	♊	17	22	27	12	♈	16	3	♈	18	58	23	39	B.	961	r
68	1783	Nov.	15	♉	24	14	53	9	♉	15	25	♉	18	55	7	3	A.	1565	d
69	1784	Jan.	21	♉	26	49	51	9	♊	20	44	♊	12	22	18	24	A.	708	r
70	1784	April	9	♊	26	52	47	55	♒	28	55	♒	18	30	40	58	B.	650	r
71	1785	Jan.	27	♐	24	12	70	14	♋	12	52	♋	3	26	24	3	A.	1143	d
72	1785	April	8	♊	4	44	87	7	♑	27	34	♐	8	31	52	41	B.	427	r

An elementary and direct Method for the numerical Calculation of Logarithms.

By M. BURJA.

EVERY logarithm may be conſidered as an exponent of the power of 10. Extract the ſquare root of 10, which is $10^{\frac{1}{2}}$, or $10^{\frac{5}{10}}$, or $10^{0{,}5}$, and 0,5 is the logarithm of a number $= 10^{\frac{1}{2}}$. Extract the fifth root of the number found, which is $(10^{\frac{1}{2}})^{\frac{1}{5}} = 10^{\frac{1}{10}} = 10^{0{,}1}$ and 0,1 is the logarithm of this number. Extract the ſquare root of this number, and you have $(10^{\frac{1}{10}})^{\frac{1}{2}} = 10^{\frac{1}{20}} = 10^{\frac{5}{100}} = 10^{0{,}05}$ and ,05 is the logarithm of the number. Its fifth root $= (10^{\frac{1}{20}})^{\frac{1}{5}} = 10^{\frac{1}{100}} = 10^{0{,}01}$, whence 0,01 = its logarithm. By purſuing this mode are obtained the numbers belonging to the logarithms ,5 ; ,1 ; ,05 ; ,01 ; ,005 ; ,001 ; ,0005 ; ,0001 ; and ſo on ad infinitum.

Multiply the number belonging to the logarithm 0,1 by itſelf, its ſquare, cube, &c. and you have $(10^{\frac{1}{10}})^{1}$, $(10^{\frac{1}{10}})^{2}$, $(10^{\frac{1}{10}})^{3}$ &c. $= 10^{\frac{1}{10}}, 10^{\frac{2}{10}} \dots 10^{\frac{10}{10}} = 10$ or $10^{0{,}1}$, $10^{0{,}2}$, $10^{0{,}3}$ …., or the numbers whoſe logarithms are 0,1, 0,2, 0,3 —— 1,0. The fourth multiplication giving the number whoſe logarithm is 0, 5, ſerves to prove that already found as well as that from which you began 0,1. and the laſt multiplication $10'$ is a proof for all the preceding operations. In the ſame manner take the powers in ſucceſſion of the number whoſe logarithm is 0,01, and ſo of the other numbers.

Take the multiples of each of the numbers found from one to nine.

Range the whole in one table, ſo that the logarithms may follow in ſucceſſion, from the greater to the leſs. Place each logarithm in form of title in the middle of the line, its number under it, and under the number its ſucceſſive multiples from one to nine, and an auxiliary table will be formed for the calculation of logarithms, which will contain the numbers in Brigg's ſyſtem, belonging to logarithms, each of which is expreſſed by a decimal fraction with a ſingle ſignificant number, conjointly with the firſt nine multiples of theſe numbers.

Suppoſing the logarithm given, to find the number belonging to it in Brigg's ſyſtem.

Let the logarithm be 0,463726. The number is

$$10,^{0{,}463726} = 10^{\frac{4}{10}} \times 10^{\frac{6}{100}} \times 10^{\frac{3}{1000}} \times \dots$$

$$= 10^{0{,}4} \times 10^{0{,}06} \times 10^{0{,}003} \times \dots$$

Or ſuppoſing NL the abſolute number of a logarithm, it is NL 0,4 × NL, 06 × NL0,003 × &c.——In the auxiliary table are the numbers of logarithms conſiſting of a decimal fraction with a ſingle number. Theſe are then to be taken out as they correſpond with the quantities laſt found, and, being ſubſtituted for them, the ſum gives the number required.

An inſtance is given to ſhew the mode of doing the inverſe of the foregoing problems, which it done alſo by the uſe of the auxiliary table: and a fourth problem ſhews the mode of calculating an auxiliary table for any baſe, which is the ſame indeed as when the baſe was 10. The laſt, which is to find the logarithm of a number without any auxiliary table, may gratify more the mathematical reader. This is done like the others, by taking a certain number. Thus, let the logarithm be ,262144 for the baſe 128; it is then requiſite to find the exponent of 128, when its power $=$ 262144. Let $262144 = 128^{p + \frac{1}{q}} = 128^{p} \times 128^{\frac{1}{q}}$ the whole number p is found by taking the neareſt power of 128 under 262144. In this caſe it is 128^{2} $\therefore 262144 = 128^{2} \times 128^{\frac{1}{q}} \therefore \frac{262144}{128^{2}} = 16 = 128^{\frac{1}{q}} \therefore 16^{q} = 128$. Let $q = r + \frac{1}{s} \therefore 16^{r + \frac{1}{s}} = 16^{r} \times 16^{\frac{1}{s}} = 128$, and finding the power of 16 neareſt to 128, and $r = 1 \therefore 128 = 16^{1} \times 16^{\frac{1}{s}} \therefore \frac{128}{16} = 16^{\frac{1}{s}} = 8 \therefore 8^{s} = 16$, let $s = t + \frac{1}{u} \therefore 8^{t} \times 8^{\frac{1}{u}} = 16$, as before t will be found equal to unity $\therefore \frac{16}{8} = 8^{\frac{1}{u}} = 2 \therefore 2^{u} = 8$ let $u = v + \frac{1}{w} \therefore 8 = 2^{v} \times 2^{\frac{1}{w}}$ and $v = 3 \therefore \frac{8}{2^{3}} = 2^{\frac{1}{w}} \therefore 1 = 2^{\frac{1}{w}} \therefore \frac{1}{w} = 0$, and the operation is finiſhed.

$$\text{Hence } x = p + \cfrac{1}{r + \cfrac{1}{s + \cfrac{1}{v}}} = 2 + \cfrac{1}{1 + \cfrac{1}{1 + \cfrac{1}{3}}}$$

$1 + \frac{1}{3} = \frac{4}{3} \therefore \frac{1}{1 + \frac{1}{3}} = \frac{3}{4} \frac{1}{1 + \frac{3}{4}} = \frac{4}{7} \therefore x = \frac{4}{27} \therefore 262144 = 128^{2\frac{4}{7}}$.

An auxiliary table is given at the end. The numbers are diſpoſed in two columns each page. The log. 0,9 is at the head of the firſt column, and its correſponding number 7,94328234724281502 06 is multiplied by the numbers under 10; the ſame is done for 0,8, and ſo on to the logarithm 0, 0000000000000000 1.

Examination of an analytical Paradox. By Mr. JOHN TREMBLEY.

IN reſolving by approximation fluxional equations, ſucceſſive ſubſtitutions have been made, but they are attended with this inconvenience, that arcs of circles are introduced into the integral, when it ought not to contain them. To rectify this mode, De la Grange and De la Place have made their arbitrary conſtant quantities to vary. On examining this analytical paradox, the method of ſubſtitutions appears to give arcs of circles, becauſe it gives in the forms of ſeries the imaginary exponentials, or the ſines and coſines, that the fluents ought to contain; and, from the nature of the method, we ought to have the integral in the form of ſeries. Now theſe ſeries being regular and capable of being ſummed, lead us directly to imaginary exponentials, and conſequently this method may lead, without the neceſſity of any rectification, to the true integral. This is ſhewn in ſeveral examples.

Let there be two equations $\frac{dy}{dx} = (1 + 2ix)\, z$, and $\frac{dz}{dx} = -(1 + 2ix)\, y$, i being ſuppoſed very ſmall. Making $i = 0$, the equations become $\frac{dy}{dx} = z$ and

$\frac{dz}{dx} = -y \therefore \frac{ddz}{dx^2} = -\frac{dy}{dx}$ and $\frac{ddy}{dx^2} = \frac{dz}{dx} \therefore \frac{ddy}{dx^2} + y = 0 \therefore y = Ae^{x\sqrt{-1}} + Be^{-x\sqrt{-1}}$. A and B being two arbitrary conſtant quantities. $\therefore z = \frac{dy}{dx} = A\sqrt{-1}.\ e^{x\sqrt{-1}} + B\sqrt{-1}.\ e^{-x\sqrt{-1}}$. To introduce i let $y = Ae^{x\sqrt{-1}} + Be^{-x\sqrt{-1}} + iy'$, $z = A\sqrt{-1}\ .\ e^{x\sqrt{-1}} - B\sqrt{-1}\ .\ e^{-x\sqrt{-1}} + iz'$. For abbreviation $y = Ae^{x\sqrt{-1}} + iy'$, $z = A\sqrt{-1}.\ e^{x\sqrt{-1}} + iz'$. $\therefore \frac{dy}{dx} = A\sqrt{-1}.\ e^{x\sqrt{-1}} + i\frac{dy'}{dx}$, $\frac{dz}{dx} = -Ae^{x\sqrt{-1}} + i\frac{dz'}{dx}$ by ſubſtituting theſe values in the primitive equations theſe two equations are obtained.

$$A\sqrt{-1}\ .\ e^{x\sqrt{-1}} + i\frac{dy'}{dx} = A\sqrt{-1}\ .\ e^{x\sqrt{-1}} + iz'$$
$$+\ 2Aix\sqrt{-1}\ .\ e^{x\sqrt{-1}},$$
$$Ae^{x\sqrt{-1}} + i\frac{dz'}{dx} = -Ae^{x\sqrt{-1}} - iy' - 2Aixe^{x\sqrt{-1}},$$
$$\therefore \frac{dy'}{dx} = 2Ax\sqrt{-1}\ .\ e^{x\sqrt{-1}} + z',\ \frac{dz'}{dx} = -2Axe^{x\sqrt{-1}} - y'.$$

From the firſt equation we obtain,

$$\frac{dz'}{dx} = \frac{ddy'}{dx^2} + 2Axe^{x\sqrt{-1}} - 2A\sqrt{-1}\ .\ e^{x\sqrt{-1}} =$$
$$-2Axe^{x\sqrt{-1}} - y',$$
$$\therefore \frac{ddy'}{dx^2} + y' = 2A\sqrt{-1}\ .\ e^{x\sqrt{-1}} - 4Axe^{x\sqrt{-1}},$$
$$\therefore y' = A\sqrt{-1}\ .\ x^2e^{x\sqrt{-1}},$$
$$z' = \frac{dy'}{dx} - 2Ax\sqrt{-1}\ .\ e^{x\sqrt{-1}} = -Ax^2e^{x\sqrt{-1}}.$$
$$y = Ae^{x\sqrt{-1}} + iA\sqrt{-1}\ .\ x^2e^{x\sqrt{-1}},$$
$$z = A\sqrt{-1}\ .\ e^{x\sqrt{-1}} - iAx^2e^{x\sqrt{-1}}.$$

Now to paſs to i^2 make

$$y = Ae^{x\sqrt{-1}} + iA\sqrt{-1}\ .\ x^2e^{x\sqrt{-1}} + i^2y'',$$
$$z = A\sqrt{-1}\ .\ e^{x\sqrt{-1}} - iAx^2e^{x\sqrt{-1}} + i^2z''.$$
$$\therefore \frac{dy}{dx} = A\sqrt{-1}\ .\ e^{x\sqrt{-1}} + 2iA\sqrt{-1}\ .\ xe^{x\sqrt{-1}}$$
$$-\ iAx^2e^{x\sqrt{-1}} + i^2\frac{dy''}{dx},$$
$$\frac{dz}{dx} = -Ae^{x\sqrt{-1}} - 2iAxe^{x\sqrt{-1}}$$

$$- i\,A x^2 \sqrt{-1} \,.\, e^{x\sqrt{-1}} + i^2 \frac{dz''}{dx},$$

By ſubſtitution, reduction, and dividing by i^2,

$$\frac{dy''}{dz} = -2Ax^3 e^{x\sqrt{-1}} + z'',$$

$$\frac{dz''}{dx} = -2Ax^3 \sqrt{-1} \,.\, e^{x\sqrt{-1}} - y''.$$

$$\therefore z'' = \frac{dy''}{dx} + 2Ax^3 e^{x\sqrt{-1}},$$

$$\frac{dz''}{dx} = \frac{ddy''}{dx^2} + 6Ax^2 e^{x\sqrt{-1}} + 2Ax^3 \sqrt{-1} \,.\, e^{x\sqrt{-1}} =$$

$$-2Ax^3 \sqrt{-1} \,.\, e^{x\sqrt{-1}} - y'';$$

$$\therefore \frac{ddy''}{dx^2} + y'' = -6Ax^2 e^{x\sqrt{-1}} - 4Ax^3 \sqrt{-1} \,.\, e^{x\sqrt{-1}},$$

And $y'' = -\frac{A}{2} \,.\, x^4 e^{x\sqrt{-1}}$.

$$\therefore z'' = \frac{dy''}{dx} + 2Ax^3 e^{x\sqrt{-1}} = -\frac{A}{2} \sqrt{-1} \,.\, x^4 e^{x\sqrt{-1}}.$$

$$\therefore y = Ae^{x\sqrt{-1}} + iA\sqrt{-1} \,.\, x^2 e^{x\sqrt{-1}} - \frac{i^2 A}{2} x^4 e^{x\sqrt{-1}},$$

$$z = A\sqrt{-1} \,.\, e^{x\sqrt{-1}} + iA\sqrt{-1} \,.\, x^2 e^{x\sqrt{-1}} - \frac{i^2 A}{2} x^4 e^{x\sqrt{-1}}.$$

Let now

$$y = Ae^{x\sqrt{-1}} + iA\sqrt{-1} \,.\, x^2 e^{x\sqrt{-1}} - \frac{i^2 A}{2} x^4 e^{x\sqrt{-1}} + i^3 y''',$$

$$z_, = A\sqrt{-1} \,.\, e^{x\sqrt{-1}} - iAx^2 e^{x\sqrt{-1}} - \frac{i^2 A}{2} \sqrt{-1} \,.\, x^4 e^{x\sqrt{-1}} + i^3 z''.$$

Making uſe only of the terms, multiplied by i^3, and dividing by i^3,

$$\frac{dy'''}{dx} = z^3 - A\sqrt{-1} \,.\, x^5 e^{x\sqrt{-1}},$$

$$\frac{dz'''}{dx} = -y''_{,} + Ax^5 e^{x\sqrt{-1}}.$$

$$\therefore z''' = \frac{dy'''}{dx} + A\sqrt{-1} \,.\, x^5 e^{x\sqrt{-1}},$$

$$\frac{dz'''}{dx} = \frac{ddy'''}{dx^2} + 5A\sqrt{-1} \,.\, x^4 e^{x\sqrt{-1}} - Ax^5 e^{x\sqrt{-1}} = -y''' + Ax^5 e^{x\sqrt{-1}}.$$

$$\therefore \frac{ddy'''}{dx^2} + y''' = -5A\sqrt{-1} \,.\, x^4 e^{x\sqrt{-1}} + 2Ax^5 e^{x\sqrt{-1}},$$

And $y''' = -\frac{1}{2.3} A\sqrt{-1} \,.\, x^6 e^{x\sqrt{-1}}$.

$$\therefore z''' = \frac{dy'''}{dx} + A\sqrt{-1} \,.\, x^5 e^{x\sqrt{-1}} = \frac{1}{2.3} Ax^6 e^{x\sqrt{-1}}.$$

$y =$

$$\therefore\; y = Ae^{x\sqrt{-1}} + \frac{iA}{1}\sqrt{-1}\,.\,x^2e^{x\sqrt{-1}} - \frac{i^2}{1.2}Ax^4e^{x\sqrt{-1}}$$
$$- \frac{i^3}{1.2.3}A\sqrt{-1}\,.\,x^6e^{x\sqrt{-1}},$$
$$z = A\sqrt{-1}\,.\,e^{x\sqrt{-1}} - \frac{iA}{1}x^2e^{x\sqrt{-1}} - \frac{i^2}{1.2}A\sqrt{-1}\,.\,x^4e^{x\sqrt{-1}}$$
$$+ \frac{i^3}{1.2.3}Ax^6e^{x\sqrt{-1}}.$$

Now let

$$y = Ae^{x\sqrt{-1}} + \frac{i}{1}A\sqrt{-1}\,.\,x^2e^{x\sqrt{-1}} - \frac{i^2}{1.2}A\,x4e^{x\sqrt{-1}}$$
$$- \frac{i^3}{1.2.3}A\sqrt{-1}\,.\,x^6e^{x\sqrt{-1}} + i^{\text{IV}}y^{\text{IV}};$$
$$z = A\sqrt{-1}\,.\,e^{x\sqrt{-1}} - \frac{i}{1}Ax^2e^{x\sqrt{-1}} - \frac{i^2}{1.2}A\sqrt{-1}\,.\,x^4e^{x\sqrt{-1}} +$$
$$\frac{i^3}{1.2.3}Ax^6e^{x\sqrt{-1}} + i^{\text{IV}}z^{\text{IV}}.$$
$$\therefore\; \frac{dy^{\text{IV}}}{dx} = z^{\text{IV}} + \frac{2}{1.2.3}Ax^7e^{x\sqrt{-1}};$$
$$\frac{dz^{\text{IV}}}{dx} = -y^{\text{IV}} + \frac{2A\sqrt{-1}}{1.2.3}x^7e^{x\sqrt{-1}};$$
$$\therefore\; z^{\text{IV}} = \frac{dy^{\text{IV}}}{dx} - \frac{2}{1.2.3}Ax^7e^{x\sqrt{-1}},$$
$$\frac{dz^{\text{IV}}}{dx} = \frac{ddy^{\text{IV}}}{dx^2} - \frac{14}{1.2.3}Ax^6e^{x\sqrt{-1}} - \frac{2\sqrt{-1}}{1.2.3}Ax^7e^{x\sqrt{-1}} =$$
$$-y^{\text{IV}} + \frac{2A\sqrt{-1}}{1.2.3}x^7e^{x\sqrt{-1}}.$$
$$\therefore\; \frac{ddy^{\text{IV}}}{dx^2} + y^{\text{IV}} = \frac{14}{1.2.3}Ax^6e^{x\sqrt{-1}} + \frac{4A\sqrt{-1}}{1.2.3}x^7e^{x\sqrt{-1}},$$

And $y^{\text{IV}} = \frac{1}{1.2.3.4}Ax^8e^{x\sqrt{-1}}$.

$$\therefore\; z^{\text{IV}} = \frac{1}{1.2.3.4}A\sqrt{-1}\,.\,x^8e^{x\sqrt{-1}}.$$
$$\therefore\; y = Ae^{x\sqrt{-1}}\left(1 + \frac{i}{1}x^2\sqrt{-1} - \frac{i^2}{1.2}x^4 - \frac{i^3}{1.2.3}x^6\sqrt{-1} + \frac{i^4}{1.2.3.4}x^8\ \&c.\right)$$
$$z = A\sqrt{-1}\,.\,e^{x\sqrt{-1}}\left(1 + \frac{i}{1}x^2\sqrt{-1} - \frac{i^2}{1.2}x^4 - \frac{i^3}{1.2.3}x^6\sqrt{-1}\right.$$
$$\left. + \frac{i^4}{1.2.3.4}x^8\ \&c.\right) \text{ or}$$
$$y = Ae^{x\sqrt{-1} + ix^2\sqrt{-1}},$$
$$z = A\sqrt{-1}\,.\,e^{x\sqrt{-1} + ix^2\sqrt{-1}}.$$

By calculating the B's

$$y = \mathrm{B}e^{-x\sqrt{-1} - ix^2\sqrt{-1}},$$

$$z = -\mathrm{B}\sqrt{-1}\,.\,e^{-x\sqrt{-1} - ix^2\sqrt{-1}}.$$

$$\therefore y = \mathrm{A}e^{(x + ix^2)\sqrt{-1}} + \mathrm{B}e^{-(x + ix^2)\sqrt{-1}};$$

$$z = \mathrm{A}\sqrt{-1}\,.\,e^{(x + ix^2)\sqrt{-1}} - \mathrm{B}\sqrt{-1}\,.\,e^{-(x + ix^2)\sqrt{-1}}.$$

$\therefore y = \mathrm{A}\ \text{coſ}\ (x + ix^2) + \mathrm{A}\sqrt{-1}\,.\,\text{ſin}\ (x + ix^2) + \mathrm{B}\ \text{coſ}\ (x + ix^2) - \mathrm{B}\sqrt{-1}\,.\,\text{ſin}\ (x + ix^2) =$ (making $\mathrm{A} + \mathrm{B} = \mathrm{A}'\ \text{ſin}\ \alpha$), $(\mathrm{A} - \mathrm{B})\sqrt{-1} = \mathrm{A}'\ \text{coſ}\ \alpha$) $\mathrm{A}'\ \text{ſin}\ (x + ix^2)\ \text{coſ}\ \alpha - \mathrm{A}'\ \text{coſ}\ (x + ix^2)\ \text{ſin}\ \alpha = \mathrm{A}'\ \text{ſin}\ (x + ix^2 + \alpha)$. In the ſame manner,

$z = (\mathrm{A} - \mathrm{B})\sqrt{-1}\,.\,\text{coſ}\ (x + ix^2) - (\mathrm{A} + \mathrm{B})\ \text{ſin}\ (x + ix^2) = \mathrm{A}'\ \text{coſ}\ \alpha\ \text{coſ}\ (x + ix^2) - \mathrm{A}'\ \text{ſin}\ \alpha\ \text{ſin}\ (x + ix^2) = \mathrm{A}'\ \text{coſ}\ (x + ix^2 + \alpha)$, agreeing with De la Grange's ſolution.

By a ſimilar proceſs the equation $\frac{ddy}{dx^2} - \frac{dy^2}{ydx^2} - \frac{idy^2}{(1 + iy)\,dx^2} + 2iy\,(1 + iy) = 0$, is ſolved and made to agree with the ſolution given by De la Grange.

Two equations of De la Place $\frac{ddy}{dt^2} + y - l + \alpha y^2 = 0$, α being very ſmall, and $\frac{ddy}{dt^2} + y - \alpha y\ \text{coſ}\ 2t = 0$, are treated in the ſame manner, and the reſults are found with equal eaſe.

Reflections on the Method of Approximation in Fluxional Equations.
By M. John Trembley.

THE general theory may be deduced from the following example.

Let $\frac{ddy}{dt^2} + y - l + \alpha y^2 = 0$, the equation of De la Place, (in the Pariſian Tranſactions for 1779). Hence

$$\frac{d^4y}{dt^4} + \frac{ddy}{dt^2} + \frac{\alpha\,dd.y^2}{dt^2} = 0, \text{ or}$$

$$\frac{d^4y}{dt^4} + \frac{ddy}{dt^2} + \frac{2\alpha\,dy^2}{dt^2} + \frac{2\alpha y\,ddy}{dt^2} = 0.$$

By multiplying the firſt by *dy*, and finding the integral, we gain

$$\frac{dy^2}{dt^2} + y^2 - 2ly + \frac{2}{3}\alpha y^3 + \mathrm{H} = 0,$$

Neglecting α we have

$$\frac{dy^2}{dt^2} = -y^2 + 2ly - \mathrm{H},\ \frac{ddy^2}{dt^2} = -y + l;$$

$$\therefore \frac{d^4y}{dt^4} + \frac{ddy}{dt^2} - 4\alpha y^2 + 6l\alpha y - 2\alpha \mathrm{H} = 0.$$

$$\alpha y^2 = l - y - \frac{ddy}{dt^2}.$$

$$\therefore \frac{d^4y}{dt^4} + \frac{5ddy}{dt^2} + (4 + 6\alpha l)\, y = 4l - 2\alpha \mathrm{H}.$$

Let $\beta^4 + 5\beta^2 + (4 + 6\alpha l) = 0$, or if $\beta^2 = \gamma$,

$$\gamma^2 + 5\gamma + 4 + 6\alpha l = 0.$$

Negle&#x1D9C;ting α^2,

$$\gamma = -1 - 2xl, \quad \gamma = -4 + 2\alpha l.$$

Taking the firſt of theſe values

$$\beta = \pm (1 + \alpha l) \sqrt{-1};$$

Taking the ſecond

$$\beta = \pm \left(2 - \frac{\alpha l}{2}\right) \sqrt{-1}.$$

Taking the firſt, I make

$$y + \alpha y^2 = \mathrm{A} + \alpha\mathrm{B} + \mathrm{C}e^{\sqrt{-1}\,(1+\alpha l)\,t} + \mathrm{D}e^{-\sqrt{-1}\,(1+\alpha l)\,t},$$

Changing the conſtant quantities

$$y + \alpha y^2 = \mathrm{A} + \alpha\mathrm{B} + \mathrm{C}\ \text{ſin}\ (1 + \alpha l)\,t + \mathrm{D}\ \text{coſ}\ (1 + \alpha l)\,t.$$

Neglecting α^2,

$$\begin{array}{lll}
y = \mathrm{A} + \alpha\mathrm{B} & + \mathrm{C}\ \text{ſin}\ (1 + \alpha l)\,t & + \mathrm{D}\ \text{coſ}\ (1 + \alpha l)\,t \\
\quad - \alpha\mathrm{A}^2 & - 2\alpha\mathrm{AC} & - 2\alpha\mathrm{AD} \\
\quad - \frac{\alpha}{2}\mathrm{C} & & \\
\quad - \frac{\alpha}{2}\mathrm{D} & & \\
- \alpha\mathrm{CD}\ \text{ſin}\ 2\,(1 + \alpha l)\,t & + \frac{\alpha}{2}\mathrm{C}\ \text{coſ}\ 2\,(1 + \alpha l)\,t & \\
 & - \frac{\alpha}{2}\mathrm{D} &
\end{array}$$

$$\therefore y = \mathrm{A} + \alpha\mathrm{B} + \mathrm{C}\ \text{ſin}\ (1 + \alpha l)\,t + \mathrm{D}\ \text{coſ}\ (1 + \alpha l)\,t + \alpha\mathrm{E}\ \text{ſin}\ 2\,(1 + \alpha l)\,t$$
$$+ \alpha\mathrm{F}\ \text{coſ}\ 2\,(1 + \alpha l)\,t,$$

we have, by ſubſtituting in the primitive equation, theſe values

$$\begin{array}{llll}
\mathrm{A} + \alpha\mathrm{B} & - \mathrm{C}\,(1 + \alpha l)^2\ \text{ſin}\ (1 + \alpha l)\,t & - \mathrm{D}\,(1 + \alpha l)^2\ \text{coſ}\ (1 + \alpha l)\,t & \\
- l + \alpha\mathrm{A}^2 & + \mathrm{C} & + \mathrm{D} & \\
\quad + \frac{\alpha C^2}{2} & + 2\alpha\mathrm{AC} & + 2\alpha\mathrm{AD} & \\
\quad + \frac{\alpha\mathrm{D}^2}{2} & & & \\
- 4\alpha\,(1 + \alpha l)^2\ \mathrm{E}\ \text{ſin}\ 2\,(1 + \alpha l)\,t & - 4\,(1 + \alpha l)^2\ \mathrm{F}\ \text{coſ}\ 2\,(1 + \alpha l)\,t & & \\
+ \alpha\mathrm{E} & + \alpha\mathrm{F} & & \\
+ \alpha\mathrm{CD} & - \frac{\alpha\mathrm{C}^2}{2} & & = 0 \\
 & + \frac{\alpha\mathrm{D}^2}{2} & &
\end{array}$$

$\therefore A = l,\ B = -\frac{\alpha(2l^2 + C^2 + D^2)}{2},\ E = \frac{CD}{3},\ F = \frac{D^2 - C^2}{6}$. C and D remain indeterminate.

$$\begin{array}{l}\therefore y = l - \frac{\alpha(2l^2 + C^2 + D^2)}{2} + C \sin(1 + \alpha l)t \\ \quad + D \cos(1 + \alpha l)t + \frac{\alpha}{3} CD \sin 2(1 + \alpha l)t \\ \quad + \frac{\alpha(D^2 - C^2)}{6} \cos 2(1 + \alpha l)t.\end{array}$$

Let $C = e \cos \pi$, $D = e \sin \pi$, we have $C^2 + D^2 = e^2$, $\frac{D}{C} = \text{tang.}\ \pi$.

$$\begin{array}{l}\therefore y = l - \frac{\alpha(2l^2 + e^2)}{2} + e \sin((1 + \alpha l)t + \pi) \\ \qquad - \frac{\alpha}{6} e^2 \cos 2((1 + \alpha l)t + \pi).\end{array}$$

as found by De la Place.

Taking the other value of γ

$$y = A + \alpha B + C \sin\left(2 - \frac{\alpha l}{2}\right)t + D \cos\left(2 - \frac{\alpha l}{2}\right)t,$$

$$\begin{array}{l}\therefore y = A + \alpha B + C \sin\left(2 - \frac{\alpha l}{2}\right)t + D \cos\left(2 - \frac{\alpha l}{2}\right)t \\ \quad + \alpha E \sin 2\left(2 - \frac{\alpha l}{2}\right)t + \alpha F \cos\left(2 - \frac{\alpha l}{2}\right)t,\end{array}$$

which gives, by ſubſtituting theſe values in the primitive equation,

$$\begin{array}{l}
\quad A + \alpha B \quad - C\left(2 - \frac{\alpha l}{2}\right)^2 \sin\left(2 - \frac{\alpha l}{2}\right)t \\
-\, l + \alpha A^2 \\
\qquad + \frac{\alpha}{2} C^2 + C \\
\qquad + \frac{\alpha}{2} D^2 + 2\alpha AC \\
\quad - D\left(2 - \frac{\alpha l}{2}\right)^2 \cos\left(2 - \frac{\alpha l}{2}\right)t \\
\quad + D \\
\quad + 2\alpha AD \\
- 4\alpha\left(2 - \frac{\alpha l}{2}\right)^2 E \sin 2\left(2 - \frac{\alpha l}{2}\right)t \\
+ \alpha E \\
+ \alpha CD \\
\quad - 4\alpha\left(2 - \frac{\alpha l}{2}\right)^2 F \cos 2\left(2 - \frac{\alpha l}{2}\right)t = 0 \\
\quad + \alpha F \\
\quad - \frac{\alpha}{2} C^2 \\
\quad + \frac{\alpha}{2} D^2.
\end{array}$$

∴ A

$$\therefore\ A = l,\ B = -\frac{\alpha(2l^2 + C^2 + D^2)}{2},\ C = 0,\ D = 0,\ E = 0,\ F = 0;$$

This value therefore cannot be of any uſe, and the reſult would not have been more ſatisfactory, if the four values of β, joined to the arbitrary conſtant quantities, had been made to enter into the value of y. Hence Mr. Couſin is miſtaken in aſſerting, in his Aſtr. Phyſ. p. 300, that the integral ſought is compounded of the four values of β joined to ſome arbitrary conſtant quantities. There are but two of theſe values which belong to this integral, and the other two are foreign to it. Theſe two values of β alſo being obtained, their ſum is not to be made equal to y, but to $y + \alpha y^2$.

Let $y + \alpha y^2 = z$, the equation propoſed becomes $\frac{ddy}{dt^2} - l + z = 0\ \therefore \frac{ddy}{dt^2} = l - z$, and $\frac{d^4y}{dt^2} = -\frac{ddz}{dt^2}\ \therefore y = z - \alpha z^2$ by neglecting the α^2. Therefore the equation of the fourth degree in y will become $-\frac{ddz}{dt^2} - 5z + 5l - 4\alpha z^2 + 6\alpha lz$
$+ 4z$
$= 4l - 2\alpha H$, or $\frac{ddz}{dt^2} + z - l - 6\alpha lz + 4\alpha z^2 - 2\alpha H = 0$. Now $\alpha z^2 = z - y\ \therefore \frac{ddz}{dt^2} + 5z - l - 6\alpha lz - 2\alpha H - 4y = 0$, and by taking the fluxions twice $\frac{d^4z}{dt^2} + \frac{5ddz}{dt^2} - \frac{6\alpha lddz}{dt^2} - \frac{4ddy}{dt^2} = 0$. Now $\frac{ddy}{dt^2} = l - z\ \therefore \frac{d^4z}{dt^4} + \frac{5ddz}{dt^2} + (4 + 6\alpha l)z = 4l + 6\alpha l^2$ (by ſubſtituting in the term $-\frac{6\alpha lddz}{dt^2}$ the value of $\frac{ddz}{dt^2} = l - z$).

This equation in z is the ſame nearly as that obtained for y. $\therefore$ As before $z = y + \alpha y^2 = A + \alpha B + C$ ſin $(1 + \alpha l)t$ + D coſ $(1 + \alpha l)t$. Hence the ſuppoſition that $y = A + \alpha B + C$ ſin $(1 + \alpha l)t$ + D coſ $(1 + \alpha l)t$, is only a particular ſuppoſition, drawn from the general ſuppoſition, by neglecting the term αy^2.

If we would approximate the equation to α^2, we muſt begin with

$\frac{d^4y}{dt^4} + \frac{ddy}{dt^2} + 2\alpha\left(\frac{dy^2}{dt^2} + \frac{yddy}{dt^2}\right) = 0$, by ſubſtituting $\frac{dy^2}{dt^2}$ and $\frac{yddy}{dt^2}$, we have

$$\frac{d^4y}{dt^4} + \frac{ddy}{dt^2} + 6\alpha ly - 2\alpha H - 4\alpha y^2 - \frac{10}{3}\alpha^2 y^3 = 0.$$

Hence taking the fluxions twice

$$\frac{d^6y}{dt^6} + \frac{d^4y}{dt^4} + 6\alpha l\frac{ddy}{dt^2} - 8\alpha\left(\frac{dy^2}{dt^2} + \frac{yddy}{dt^2}\right) - \frac{10}{3}\alpha^2\, dd.\, y^3 = 0,$$

By new ſubſtitutions, and the neceſſary reductions,

$$\frac{d^6y}{dt^6} + \frac{14d^4y}{dt^4} + (49 + 56\alpha l)\frac{ddy}{dt^2}$$
$$+ (36 + 104\alpha l + 20\alpha^2 H)y - 36l - 18\alpha H - 50\alpha l = 0.$$

Hence is made the equation

$$\beta^6 + 14\beta^4 + (49 + 56\alpha l)\beta^2 + 36 + 104\alpha l + 20\alpha^2 H = 0,$$

making $\beta^2 = \gamma$,

$$\gamma^3 + 14\gamma^2 + (49 + 56\alpha l)\gamma + 36 + 104\alpha l + 20\alpha^2 H = 0.$$

make $\gamma = -1 - 2\alpha l + n\alpha^2$, ſubſtitute this value neglecting α^3, we find $n = \frac{17}{6} l^2 + \frac{5}{6} H$.

$$\therefore \gamma = -1 - 2\alpha l + \frac{17}{6}\alpha^2 l^2 + \frac{5}{6}\alpha^2 H,$$

$$\beta = \pm\sqrt{-1}\sqrt{(1 + 2\alpha l - \frac{17}{6}\alpha^2 l^2 - \frac{5}{6}\alpha^2 H)}$$

$$= \pm\sqrt{-1}\sqrt{((1 + \alpha l)^2 - \frac{23}{6}\alpha^2 l^2 - \frac{5}{6}\alpha^2 H)}$$

$$= \pm\sqrt{-1}\,(1 + \alpha l - \frac{23}{12}\alpha^2 l^2 - \frac{5}{12}\alpha^2 H) =$$

(making $H = b - l^2$)

$$\pm\sqrt{-1}\,(1 + \alpha l - \frac{3}{2}\alpha^2 l^2 - \frac{3}{12}\alpha^2 H).$$

Make therefore

$$y + \alpha y^2 + \alpha^2 y^3 = A + \alpha B + \alpha^2 C + D\,\text{ſin}\,(1 + \alpha l - \frac{3}{2}\alpha^2 l^2 - \frac{5}{12}\alpha^2 b)t + E\,\text{coſ}\,(1 + \alpha l - \frac{3}{2}\alpha^2 l_2 - \frac{5}{12}\alpha^2 b)t.$$

As above the value of $\alpha^2 y3$ muſt be added, and making for abbreviation $\varphi = 1 + \alpha l - \frac{3}{2}\alpha^2 l^2 - \frac{5}{12}\alpha^2 b$, we have

$$\begin{aligned} y = {} & A + \alpha B + \alpha^2 C + D\,\text{ſin}\,\varphi t + E\,\text{coſ}\,\varphi t \\ & + (\alpha F + \alpha^2 G)\,\text{ſin}\,2\varphi t + (\alpha H + \alpha^2 I)\,\text{coſ}\,2\varphi t \\ & + \alpha^2 K\,\text{ſin}\,3\varphi t + \alpha^2 M\,\text{coſ}\,3\varphi t, \end{aligned}$$

Subſtitute theſe values in the equation propoſed, and

$$\begin{array}{lll} A + \alpha B + \alpha^2 C & - D\varphi^2\,\text{ſin}\,\varphi t & - E\varphi^2\,\text{coſ}\,\varphi t \\ - l + \alpha A^2 + 2\alpha^2 AB & + D & + E \\ \quad + \frac{\alpha}{2} D^2 & + 2\alpha AD & + 2\alpha AE \\ \quad + \frac{\alpha}{2} E^2 & + 2\alpha^2 BD & + 2\alpha^2 BE \\ & - \alpha^2 DH & + \alpha^2 DF \\ & + \alpha^2 EF & + \alpha^2 EH \end{array}$$

— 4

$$\begin{array}{lll}
-4(\alpha F+\alpha^2 G)\varphi^2 \text{ ſin } 2\varphi t & -4(\alpha H+\alpha^2 I)\text{ coſ } 2\varphi t & \\
+\alpha F+\alpha^2 G & +\alpha H+\alpha^2 I & \\
+2\alpha^2 AF & -\frac{\alpha}{2}D^2 & \\
+\alpha DE & +\frac{\alpha}{2}E^2 & \\
 & +2\alpha^2 AH & \\
-9\alpha^2\varphi^2 K \text{ ſin } 3\varphi t & -9\alpha^2 M\varphi^2 \text{ coſ } 3\varphi t & \\
+\alpha^2 K & +\alpha^2 M & \\
+\alpha^2 DH & -\alpha^2 DF & =0 \\
+\alpha^2 EF & +\alpha^2 EH &
\end{array}$$

1ſt Col. gives $A = l$, 2d $B = -\frac{(2l^2 + D^2 + E^2)}{2}$, 3d $C = -2Bl$, 4th

$$\varphi^2 = 1 + 2\alpha A + 2\alpha^2 B - \alpha^2 H + \frac{\alpha^2 EF}{D} =$$

$$1 + 2\alpha l - 2\alpha^2 l^2 - \alpha^2(D^2 + E^2) - \alpha^2 H + \frac{\alpha^2 EF}{D},$$

5th $\varphi^2 = 1 + 2\alpha l - 2\alpha^2 l^2 - \alpha^2(D^2 + E^2) + \alpha^2 H + \frac{\alpha^2 DF}{E}$.

By comparing the two laſt equations

$$2H = \frac{EF}{D} - \frac{DF}{E} = \frac{F}{DE}(E^2 - D^2),\ H = \frac{F}{2DE}(E - D^2).$$

6th $-4\varphi^2\alpha F + \alpha F + \alpha DE - 4\varphi^2\alpha^2 G + 2\alpha^2 Fl = 0$.

Multiply by α, and uſing the terms φ^2 only which do not contain α^2, $\varphi^2 = 1 + 2\alpha l$, which furniſhes two equations, $-4\alpha F + \alpha F + \alpha DE = 0$, $-8\alpha^2 Fl - 4\alpha^2 G + 2\alpha^2 Fl = 0$.

The 1ſt gives $F = \frac{DE}{3}$, 2d, $G = -2Fl = -\frac{2DEl}{3}$.

$\therefore H = -\frac{1}{6}(D^2 - E^2)$, $\varphi^2 = 1 + 2\alpha l - 2\alpha^2 l^2 - \alpha^2(D^2 + E^2) - \frac{\alpha^2}{6}(D^2 - E^2) + \frac{\alpha^2 D^2}{3} = 1 + 2\alpha l - 2\alpha^2 l^2 - \frac{5\alpha^2}{6}(D^2 + E^2) =$ (making $b = D^2 + E^2$) $1 + 2\alpha l - 2\alpha^2 l^2 - \frac{5\alpha^2}{6}b$, as found above. The operation gives us the value of φ, without knowing it before, and the 7th column gives the two equations

$$-4\alpha H + \alpha H - \frac{\alpha}{2}D^2 + \frac{\alpha}{2}E^2 = 0,$$

$$-8\alpha^2 Hl - 4\alpha^2 I + \alpha^2 I + 2\alpha^2 Hl = 0.$$

Firſt gives $H = -\frac{1}{6}(D^2 - E^2)$, as above. The ſecond gives $I = -2Hl = \frac{l}{3}(D^2 - E^2)$.

The 8th column gives

$$8K = DH + EF = -\frac{D}{6}(D^2 - E^2) + \frac{DE^2}{3} = -\frac{1}{6}(D^3 - 3E^2D).$$

The 9th column gives

$$8M = EH - DF = -\frac{E}{6}(D^2 - E^2) - \frac{D^2E}{3} = -\frac{E}{6}(3D^2 - E^2).$$

$$\therefore y = l - \frac{\alpha(2l^2 + D^2 + E^2)}{2} + \alpha^2(2l^2 + D^2 + E^2)l$$
$$+ D\,\text{ſin}\,(1 + \alpha l - \tfrac{3}{2}\alpha^2 l^2 - \tfrac{5}{12}\alpha^2(D^2 + E^2)t)$$
$$+ E\,\text{coſ}\,(1 + \alpha l - \tfrac{3}{2}\alpha^2 l^2 - \tfrac{5}{12}\alpha^2(D^2 + E^2)t)$$
$$+ (\frac{\alpha DE}{3} - \frac{2\alpha^2 DEl}{3})\,\text{ſin}\,2\,(1 + \alpha l - \tfrac{3}{2}\alpha^2 l^2 - \tfrac{5}{12}(D^2 + E^2)t)$$
$$+ (\frac{\alpha}{6}(E^2 - D^2) + \frac{\alpha^2}{3}l(D^2 - E^2)\,\text{coſ}\,2\,(1 + \alpha l - \tfrac{3}{2}\alpha^2 l^2 - \tfrac{5}{12}\alpha^2(D^2 + E^2)t)$$
$$- \frac{\alpha^2 D}{48}(D^2 - 3E^2)\,\text{ſin}\,3\,(1 + \alpha l - \tfrac{3}{2}\alpha^2 l^2 - \tfrac{5}{12}\alpha^2(D^2 + E^2)t)$$
$$- \frac{\alpha^2 E}{48}(3D^2 - E^2)\,\text{coſ}\,3\,(1 + \alpha l - \tfrac{3}{2}\alpha^2 l^2 - \tfrac{5}{12}\alpha^2(D^2 + E^2)t).$$

As above make $D = e\,\text{coſ}\,\theta$, $E = e\,\text{ſin}\,\theta$, then $e^2 = D^2 + E^2$, $\frac{E}{D} = \text{tang.}\,\theta$.

$$\therefore y = l - \frac{\alpha(2l^2 + e^2)}{2} + \alpha^2(2l^2 + e^2)l$$
$$+ e\,\text{ſin}\,((1 + \alpha l - \tfrac{3}{2}\alpha^2 l^2 - \tfrac{5}{12}\alpha^2 e^2)\,t + \theta)$$
$$- \frac{\alpha}{6}e^2(1 - 2\alpha l)\,\text{coſ}\,2\,((1 + \alpha l - \tfrac{3}{2}\alpha^2 l^2 - \tfrac{5}{12}\alpha^2 e^2)\,t + \theta)$$
$$- \frac{\alpha^2 e^3}{48}\,\text{ſin}\,3\,((1 + \alpha l - \tfrac{3}{2}\alpha^2 l^2 - \tfrac{5}{12}\alpha^2 e^2)\,t + \theta).$$

As found by De la Place, p. 280. The ſubſtitution $H = h - l^2$ was indicated by the equation itſelf, for it is found that

$$2l^2 + \frac{5}{6}(D^2 + E^2) = \frac{17}{6}l^2 + \frac{5}{6}H,$$

or $\frac{5}{6}H = \frac{5}{6}(D^2 + E^2) - \frac{5}{6}l^2$,

or $H = D^2 + E^2 - l^2 = h - l^2$.

This method may be applied to moſt of the equations which are ſolved by approximation, is ſhewn in other inſtances.

Theorem

Theorem on plano-ſuperficial Solids. *By M.* LHUILIER.

IN a late work of this writer, entitled Polygonometrie, is an algebraical demonſtration of a property of rectilineal figures reſpecting the centre of gravity. A geometrical demonſtration is now given,as well on account of its elegance as its application to the theorem on ſolids.

If, from a point taken on the plane of a rectilineal figure, lines are drawn reſpectively equal or proportional to its ſides, and parallel to them in the ſame direction, this point is the common centre of gravity of the extremities of theſe right lines.

1ſt. Let ABC be a triangle. From the vertex C draw CB′ equal and parallel to AB, extend BC to B″, making CB″ = CB, then C is the centre of gravity of the points AB′ B″.

Join AB′, BB′, AB″, B′B″, and let AC produced meet B′B″ in *b*.

BB′ being parallel to AC, the triangles B″ C *b*, B″ BB′ are ſimilar, and ∴ B″ *b* = *b* B′. In the parallelogram A B C B′ the diagonals biſect each other ∴ in the triangle AB″B′, C is the centre of gravity of the points AB″B′, ſince the lines A*b*, B″B, interſecting each other at C, biſect the ſides oppoſite to A and B″.

Let the plane figure ABC . . . . . . LMN have any number of ſides. Through the vertex N draw the lines NB′, NC′, ... N′L, NM′ reſpectively equal and parallel to the ſides AB, BC . . . . IL, LM, and extend MN ſo that NM″ = NM; then N is the centre of gravity of A, B′, C′ . . . L′, M′, M″. Produce the lines BN, CN . . . . . . LN, to the other ſide of N, and make the lines B″N, C″N . . . . . . ″LN equal to them.

In the triangles ABN, BCN . . . . . LMN, the point N is the centre of gravity of the points

$$\begin{array}{cccccc} A & B & C & \qquad & I & L \\ B' & C' & D' & & L' & M' \\ B'' & C'' & D'' & & L'' & M'' \end{array}$$

Therefore it is the centre of gravity of all theſe points taken collectively. But ſince N biſects each of the lines BB″, CC″ . . . . . II″, LL″, it is the common centre of gravity of the points

$$\begin{array}{cccccc} B & C & D & \qquad & I & L \\ B'' & C'' & D'' & & I'' & L'' \end{array}$$

Therefore it is the common centre of gravity of the remaining points A, B′, C′ . . . . . L′ M″.

Theorem for plano-ſuperficial ſolids.

From a point in the ſolid draw right lines in the direction of the perpendiculars to the ſurfaces of a plano-ſuperficial ſolid, and proportional to theſe ſurfaces, the point from which theſe perpendiculars are drawn is the common centre of gravity of their extremities.

Let ABC be the baſe and S the vertex of a triangular pyramid. From S draw SA′, SB′, SC′, perpendicular and proportional to the ſurfaces ASB, BSC, CSA, and

SP' perpendicular and proportional to the baſe. Then S is the common centre of gravity of the points A', B', C', P'.

Let SP be the height of the pyramid. Sa, Sb, Sc, the heights of the ſurfaces, ASB, BSC, CSA. Through S draw a plane parallel to the baſe; and on this plane let fall the perpendiculars $A'a'$, $B'b'$, $C'c'$. Draw the right lines Pa, Pb, Pc, Sa', Sb', Sc'.

The triangles SaP, SbP, ScP are reſpectively ſimilar to the triangles $SA'a'$, $SB'b'$, $SC'c'$. $\therefore$ Sa', Sb', Sc' are as $SP \times \frac{SA'}{Sa}$, $SP \times \frac{SB'}{Sb}$, $SP \times \frac{SC'}{Sc}$, or, as $AB \times \frac{SP \times SA'}{Sa \times AB}$, $BC \times \frac{SP \times SB'}{Sb \times BC}$, $CA \times \frac{SP \times SC'}{Sc \times CA}$, but SA', SB', SC', are reſpectively proportional to the rectangles $Sa \times AB$, $Sb \times BC$, $Sc \times CA$ $\therefore$ Sa', Sb', Sc', are proportional to the ſides AB, BC, CA. But they are parallel to the perpendiculars on theſe ſides $\therefore$ the point S is the common centre of gravity of the points a', b', c'. But the centre of gravity of the points A', B', C', is in the perpendicular to the plane drawn through S. Therefore it is on the perpendicular SP. But the point P' is alſo in this perpendicular, therefore the common centre of gravity of all theſe points $A'B'C'P'$ is in this perpendicular.

By ſimilar triangles $A'a'$, $B'b'$, $C'c'$, are, as $Pa \times \frac{SA'}{Sa}$, $Pb \times \frac{SB'}{Sb}$, $Pc \times \frac{SC'}{Sc}$, or $Pa \times AB \times \frac{SA'}{Sa \times AB}$, $Pb \times BC \times \frac{SB'}{Sb \times BC}$, $Pc \times CA \times \frac{SC}{Sc \times CA}$ $\therefore$ $A'a'$, $B'b'$, $C'c'$, are proportional to the rectangles $Pa \times AB$, $Pb \times BC$, $Pc \times CA$, or to the triangles APB, BPC, CPA.

Therefore the ſum of theſe lines is proportional to the ſum of theſe triangles, that is to the baſe ABC. But SP' is proportional in the ſame manner to the baſe ABC. $\therefore$ $SP = A'a' + B'b' + C'c'$ $\therefore$ The centre of gravity of the points $A'B'C'P'$ is in the plane paſſing through S perpendicularly to SP, it is alſo in the right line SP. Therefore S is the centre of gravity.

Let a plano-ſuperficial ſolid be divided into triangular pyramids according to the number of ſurfaces, and by a ſimilar mode of demonſtration to that uſed for plane figures, it will appear that the point, from which are drawn lines perpendicular and proportional to the ſurfaces, is the common centre of gravity of theſe right lines.

This principle has led the writer, he tells us, to many properties of ſolids, which will ſerve as materials for another branch of Geometry, named by him Polyhedrometry, which is to be the ſubject of a future Memoir.

Reflections on the Pleaſures and Pains of Life, compared with reſpect to Number, Repetition and Variety. By Mr. DE BEGUELIN.

A SCALE of Pleaſure and Pain may be made as in a thermometer, the point o marking the limit of pleaſure and the beginning of pain. From o upwards, a certain ſpace may be marked for what may be called eaſe ſimply, and as many degrees below for uneaſineſs; beyond thoſe points, pleaſure or pain, properly ſo called, may commence. Of the many perſons in the ſtate marked uneaſineſs, few chuſe to renounce life; whence it may be inferred that, in the unhappy ſtate, there is ſtill ſome portion of eaſe, and the ordinary ſituation of life is confined to eaſe mixt with a portion of uneaſineſs, great pleaſures and great pains being rare. The ſtate of eaſe being habitual, pleaſure of equal intenſity with pain will appear leſs lively, and equal moments of each will appear unequal in duration. For we call every thing pleaſure which exceeds our habitual ſtate, and pain, where this habitual ſtate loſes ſomewhat of its intenſity. Let the ordinary intenſity be eſtimated at 10°, and let fifty degrees of pleaſure and pain be alternately poſſeſſed. The abſolute intenſity of the pleaſure will, from the habitual ſtate having been 10°, be eſtimated only at 40; but to the fifty degrees of pain muſt be added the 10° of habitual pleaſure now loſt, and the ſtate of pain will appear to be at 60°. Thus intenſities really equal will be to each other : : 2 : 3, and whilſt the pleaſure appears to laſt only two hours, the pain will ſeem to have been ſuffered three hours.

Pleaſure is evidently made for us, and we for pleaſure; when not carried to an unnatural exceſs, ſo far from ſhortening, it lengthens life; it increaſes the force of both body and ſpirit. On the contrary, pain does not ſympathiſe with our conſtitution, but undermines and deſtroys it. Hence we might preſume, that the author of our nature had ſcattered more of pleaſure than of pain over the walk of life; and the leaſt inquiry into the ſtate of men will prove, that this is really the caſe. For the greater part of mankind is in the ſtate of habitual eaſe, which conſiſts,

1ſt. In the agreeable ſenſation of ſimple exiſtence.

2. In the enjoyment of health, which, if not perfectly good, is in general, to the decline of life, tolerably good.

3. In a daily ſucceſſion of action and repoſe bringing an agreeable variety of ſenſations, ſometimes animated, ſometimes tranquil, without any mixture of mental or bodily pain.

4. The comfort attending the daily ſatisfying of many of our natural wants, which ſome may be inclined to place very high in the ſcale of pleaſure.

5. In curioſity, an inexhauſtible fund of little enjoyments.

6. In the intereſt which we have in the variety of ſcenes daily unfolded on the theatre of the univerſe.

7. In the enjoyment of ſociety and friendſhip, and in the memory and recital of paſt pleaſures and pains.

8. In the ſatisfaction of inſtructing and being inſtructed.

9. In the variety of occupations and amuſements proper to exerciſe the force of body or mind, in difficulties conquered, duties ſatisfied, and a thouſand agreeable ſenſations of all ſorts, in a mind habitually inclined to ſeek and enjoy the beſt ſide of every thing.

10. In hope anticipating the enjoyment of good, whoſe poſſibility is ſeized by the imagination.

To this enumeration of the advantages of life, it may be objected that, if the preponderance is ſo great in favour of pleaſure, it is extraordinary, that no one is willing to renew the career of life. To this we anſwer, that the ſame tune perpetually repeated will loſe its charms; that we are made too to be continually advancing, and that, in beginning the race anew, not only curioſity and hope would be loſt, but our previous knowledge would be of no advantage to us, and at the end we ſhould only be in the ſame place from whence we ſet out. But could the offer be made to a being of the continuance of life with a ſucceſſion of new ideas, though the pleaſure were greatly diminiſhed, not only the greater part of mankind would accept the terms with joy, but moſt of our pretended philoſophers, who, confining their views to this life, have not, while they complain of it, the courage to put an end to their exiſtence, would be found among the number.

Conſiderations on the State of Nature. *By M.* ANCILLON.

THE ambiguity of the term *ſtate of nature* is ſhewn in this memoir. In treating of man, nature and the ſtate of nature are continually confounded; that which is natural, with that which ſubſiſted in the ſtate of nature; and that is called againſt nature, which ought only to have been named unknown in the ſtate of nature. In the Supreme Being alone nature and ſtate are ſynonymous, becauſe, whatever can be in his eſſence does exiſt in him; but it is not ſo with man, for it would be unphiloſophical to ſay, that he cannot be to-day naturally in a certain ſtate becauſe he had never been in that ſtate before.

Since the term, however, ſtate of nature, has been uſed, there muſt be ſome ſtates oppoſite to it. Rouſſeau has found his ſtate of nature in the primitive ſtate, as he calls it, of man, and the ſubſequent ſtates are in oppoſition to it. Then he found it neceſſary to make his original men mere brutes, that he might the better oppoſe them to men in ſociety. But he is not aware of the contradictions interſperſed throughout in his writings on this ſubject. He gives to men language only like the brutes, and inſinuates that they might have been quadrupeds: but if this had been the eſſential ſtate of man at any time, how was the change to have been in the ſpecies? Eſſences are eternal, and a ſpecies of creatures once defined can never become another ſpecies. Other contradictions in Rouſſeau are pointed out, and the ſum of the whole is (what in this country will hardly admit of a diſpute), that there never was ſuch a ſtate as Rouſſeau calls a ſtate of nature, but that the preſent ſtate of man is as much a ſtate of nature as any that preceded it. The preſent ſtate is the reſult of the development of thoſe faculties in man, which he naturally poſſeſſed from the beginning, but which had not the ſame materials to work upon. What he was naturally at his creation, he is become naturally by various changes upon the theatre, on which he is placed.

Reſearches on the Liberty of Man. *By* M. de CASTILLON.

THIS writer conceives, that philoſophers ſhould never have diſcuſſed publickly the queſtion of the liberty of man; for every thing is loſt, and nothing can poſſibly be gained, by determining the queſtion in the negative; but, ſince it has been made the ſubject of diſcuſſion, the ſame principles, which ſhould have led us to conceal it, ought now to excite us to throw as much light as poſſible upon this dangerous topick. An elaborate diſcourſe now follows, which cannot, after the many diſcuſſions in our own language on this ſubject, afford much amuſement or improvement to an Engliſh reader. The common argument is brought in proof of liberty, that a man may walk or ſtand ſtill, juſt as he pleaſes; and if the neceſſarian denies that this is liberty, an appeal is made only to experience. The concluſions drawn by the writer, however, ſeem to bear hard upon his own opinion.

1. The active faculty of chuſing ſuppoſes neceſſarily ſufficient knowledge to diſtinguiſh one object of choice from another. A man of greater penetration may be free, when another is not, becauſe the latter, perceiving only one object of choice, is deprived of the faculty of chuſing, and conſequently of liberty.

2. The more enlightened a man is, the more will he weigh all the motives for or againſt the choice he is about to make, and will be determined by the beſt motives: for, in maintaining that a man may chuſe between motives, and determine from the weakeſt, or without any, we ſuppoſe, that a reaſonable being will be determined by the beſt. Hence the moſt enlightened man may be leſs free than his inferior; for, ſeeing the inutility, and even danger, of ſeveral objects of choice, he will exclude them at once from the number; whilſt the other, not having the ſame knowledge, muſt waver between a greater number of objects.

3. The enlightened and virtuous man is leſs free than one equally enlightened, but indifferent to vice or virtue. The former can chuſe only virtuous objects, the latter can chuſe on either ſide. But it is almoſt impoſſible for a bad man, ſince he is blinded by his paſſions, to be ſo enlightened as a virtuous man. Beſides, the virtuous man has not loſt entirely the faculty of choice; the active faculty is become only paſſive, and the internal ſatisfaction perceived from the preference given to virtue recompenſes him amply for his loſs.

4. Liberty increaſes and diminiſhes with knowledge and virtue. A man giving himſelf up to vice grows daily leſs able to reſiſt it. His liberty diminiſhes conſtantly, becauſe the active faculty of chuſing between vice and its oppoſite virtue tends to become, and at laſt is really paſſive. In the ſame manner the virtuous man becomes at laſt incapable of chuſing vice.

5. The faculty of procuring the object of our choice does not always depend upon ourſelves. To obtain any end deſired, a man can only chuſe among the methods preſent to his mind, put in action thoſe within his reach, and wait the event. Now, with our knowledge, the number of objects deſirable is increaſed, alſo we can eaſier diſcover the way to obtain them. The power of man, therefore, increaſes with his knowledge; and, if on the one ſide he ſometimes loſes his liberty by it, on the other it renders the degree of liberty which remains more uſeful and more efficacious.

Treatiſe of Elementary Morality. *By* M. FORMEY.

"ALL men are born perfectly equal. They have the ſame weakneſs, the ſame incapacity of ſubſiſting by themſelves, the ſame need of ſupport from others." At his birth man is inferior to all other animals, though there is a hidden ſpark which time and circumſtances elicit; and then reaſon proves his ſuperiority to the reſt of the creation. Natural and primitive equality can ſubſiſt only whilſt there is no ſociety, from whence ſprings an inequality of conditions. But ſince a child could not ſupport itſelf in a ſtate of nature, and his very birth ſuppoſes conjugal, and afterwards paternal, love, he muſt, from the want of ſtrength and intellect, be for ſome time in a ſtate of dependence on his parents.

When the children become adults, they form new ſocieties or families, whoſe heads would for ſome time be independent of each other; but the evil diſpoſitions of ſome render it neceſſary for the reſt to combine together for ſelf-defence, and inequality neceſſarily takes place. Superiority of ſtrength would be the firſt principle of inequality, as hiſtory proves to us in the characters of Nimrod, the Argonauts, and the other heroes of antiquity. Genius, addreſs, cunning, policy would afterwards obtain their end; and to their united efforts ſtrength muſt give way. Thus Ulyſſes prevailed over Ajax; Demoſthenes reſiſted Philip; Cicero ſaved his country. Hence it is evident that equality is deſtroyed both by ſtrength and talents.

The moſt efficacious method of uniting natural equality with civil inequality, is that uſed in democracies, where military and civil poſts are conferred for a limited time; after which the citizen retires tranquilly to his cottage and his plough. The hope of being one day diſtinguiſhed elevates the ſoul to noble actions, but languor and degeneracy muſt be the fate of thoſe who are placed in a condition, from which they are perſuaded they can never extricate themſelves. This is the lot of peaſants and common ſoldiers. The firſt are tied down to the plough, yet the roſes inſtituted at Salency ſhew us, that virtue may be found and encouraged among the peaſantry. As to ſoldiers, I know not any mortals more miſerable; vile pay, toil, and cruel treatment are their daily bread in time of peace; in war, they either periſh unknown, or bring back the wretched fruit of their deſtructive trade. Forty years ſervice and fifty wounds ſcarce open the gates of the invalids, with whom they finiſh their career in a ſtate of vegetation. Was it then worth while, for ſuch a life, to come into the world?

Nobility, a modern invention, chimerical diſtinction, choaks the ſeed of every ſort of talent in thoſe, who are diſgraced by ignoble birth. If, however, nobility has its uſeful ſide, and ought to have a place among thoſe rewards of which ſovereigns are the diſpenſers, it ought to be hereditary only for thoſe who are not a diſgrace to it. An inquiry after pretended nobles is certainly neceſſary, but cowardly or vicious nobles require it more. But where ſhall we find the cenſors? Would not corruption inſinuate itſelf into their tribunal as into all others?

Though democracy attacks leaſt natural equality, there are inconveniences in this form of government, which prevent us from giving it the preference. Firſt, the rudeneſs, ignorance, clowniſhneſs, and inflexibility of men elevated from the loweſt walks of life to the higheſt poſts render them odious and contemptible; and, if politics are leſs the art of governing than deceiving mankind; of obtaining by deluſion a certain end; never will tradeſmen or artiſans underſtand the ſecrets of the art, nor be capable of putting them into practice. A ſecond evil attached to democracy is the number of heads in council, and the multiplicity of advice. The time is paſſed in debates, noiſe, quarrels, faction. Parliaments! Diets! Councils! what are they? Each a chaos, where diſcord reigns, and from whence reaſon is baniſhed. Laſtly, the people is a miſchievous beaſt, difficult to tame, and eaſily returning to its priſtine ferocity. Hence continual tumults and inſurrections; and of what uſe is liberty to me, a peaceable citizen, if after a day of tranquillity my houſe ſhould on a ſudden be deſtroyed, pillaged, conſumed? I had rather ſee around me a ſtrong garriſon to keep mutiny in ſubjection, and to bend the moſt untractable to the yoke of ſovereign authority.

Ariſtocracy appears more ſpecious, becauſe the governors ought to be more enlightened, prudent, moderate, equitable. They ought, but are they ſo in reality? Does not ambition ſeize the mind of ſome, and the ſtate is torn to pieces by the acrimony of contrary factions? Another complaint againſt this form is the weight of its yoke. Avarice joins itſelf to ambition, the chiefs deſpiſe their inferiors, tread them under foot, and load them with every ſort of oppreſſion.

Monarchy comes now to be conſidered, and we will firſt examine it as limited. In this caſe, from the union of different powers ariſes a perpetual ſource of altercation. Elizabeth ſilenced her parliaments. James I. was their ſport. Charles I. died on the ſcaffold. All the Stuarts found their misfortunes in the barriers which they wiſhed, but were not able to force. In later times, and ſince the Houſe of Hanover is on the throne, the venality of parliament enables the kings to reign. But how? expoſed to ſarcaſm and injury, continually embarraſſed in their operations, and daily entangling more the Gordian knot, which they can neither untie nor cut.

Elective monarchies are worſe than hereditary. The diſputes on a vacancy ſufficiently manifeſt this; and after the election, the country is ſtill little likely to be well governed. For the new king will either not be powerful enough to command reſpect, or he muſt uſurp a tyrannical authority. In the election of popes every ſort of abſurdity is uſed to make this form the worſt that can be imagined.

Hereditary monarchy, without any other limitation than thoſe laws, to which a wiſe prince would be the firſt to conform, is, in ſhort, preferable to every other form of government. Not, that it has not ſome inconveniences. A family, long accuſtomed to royalty, is in danger of conceiving itſelf formed of different materials from the reſt of mankind, and from thence of making itſelf by pride as odious as it might otherwiſe be amiable. The character of ſovereigns is in general better; their education inſpires them with nobler ſentiments, though oftentimes its effects are ruined by ſubſequent flattery. Under a king, thus ſpoiled, and puffed up at the ſame time, like Louis XIV. with ambition, the ſubjects may be expoſed to greater misfortunes than thoſe under ariſtocracy or democracy.

Hereditary ſucceſſion may alſo place upon the throne idiots, madmen, or princes incapable and unworthy to hold the reins of government. And in caſe of minorities the kingdom muſt be expoſed to the greateſt misfortunes.

With reſpect to the mode of government itſelf we may ſtill find inconvenience. The prince wiſhes to ſee every thing with his own eyes, to be acquainted with the whole of his affairs, to decide by himſelf, and to follow his own mode of thinking. The project is praiſeworthy; but royalty becomes in this manner a moſt ſlaviſh trade. To do every thing is impoſſible; though ſome princes will, by regularity, expedite more buſineſs in a few hours than others in as many months. The chief object, indeed, of their concern ought to be military affairs; and the point of greateſt importance is to know, whether they are equally prepared for war offenſive or defenſive. Inſurrections become more and more impracticable, where the citizen is ſurrounded with ſoldiers, who at the firſt motion will lay hands on him. The authority of kings is proportional to the number of troops. The want of reſpect, which the king of England ſo often experiences, is owing to the want of a ſufficient number of troops at his command. It is true that every king well-armed may, like Achilles, deny that laws were made for him; and from abſolute may become deſpotical; from deſpotical, tyrannical: but, as I ſaid in ſpeaking of the abuſes of ariſtocracy and democracy, I had rather run the riſque of the abuſe of monarchical power. The progreſs of knowledge, and the principles of humanity and honour, will prevent us from ſeeing again a Caligula or a Nero.

The mode of governing uſed by the Caliphs, that of frequenting in diſguiſe various parts of their kingdom, could hardly be practiſed, and is ſcarcely decent in the preſent days. A third mode is ſtill more diſguſting; that of eſpionage, or of entertaining ſpies on the conduct of the ſubject in every part of the kingdom. Thus the bonds of mutual friendſhip are broken, a gloomy ſilence prevails, and even that ſilence may be conſidered as a crime. Can princes learn any thing by this mode worthy of their attention? Muſt they not know that ſpies are of ſo baſe and perfidious a nature, that, whether from malignity or ſelf-intereſt, they will white-waſh guilt, and blacken innocence? Let the ſovereign be the father of his people, and there will be no more ſecret murmurs; no other ſounds will be heard than thoſe of love and gratitude. This is enough to ſhew, that the prince ought not to wiſh to ſee every thing, for he cannot; and if he could, this prerogative would often be more hurtful than uſeful.

Let us now examine kings according to the title given them by Homer: when they are *δημοβοροι*, devourers of their people either by extravagance or avarice. In the firſt caſe they ruin their ſubjects without enriching themſelves; in the ſecond, without enjoying their riches. But they are puniſhed for their rapacity. Their tax-gatherers put the greater part of theſe ill-acquired gains into their own pockets; and beſides, in this race of dæmons is a ſubordinate claſs, which ſeizes for the tax the milk, the cow, and the pot of the poor peaſant. Princes! aboliſh every cruel mode of raiſing your revenues; let the provinces levy themſelves the taxes, and bring them to the foot of the throne; every thing will then be in order, each man will be happy according to his ſtate in life, and will not be afraid of giving birth to men, doomed otherwiſe to be unhappy.

If ſuch are the evils of monarchy, one might be tempted to flee to any form in preference; but a wiſe man does not ſo raſhly determine. Monarchy may have theſe inconveniences, but they are not conſtantly attached to it. If one prince has certain faults, he is free from others; he ſeldom unites all in his own perſon. But it is in vain to talk of fleeing to the woods on this account. Children ſuffer ſometimes from the caprices of their parents; but the paternal houſe is better than a refuge with ſtrangers; and to prefer the luxury of Otaheite to the ſocial life of Europe, muſt be the mark of a depraved and ſenſual mind.

A good king is the ſovereign political good. If there were only one in an age, happineſs would not only be the attendant on his government, but it would leave ſuch fruitful ſhoots, as would ſpring up in ſpite of the obſtacles oppoſed in leſs favourable reigns. And even ordinary kings, whoſe vices or virtues alternately prevail, exerciſe a ſpecies of dominion, to which I had much rather ſubmit, than to that of the multitude or the ariſtocrates. But I will not renounce my predilection in favour of monarchy, where it is unlimited, though it might be objected, that in this caſe I open the door to the moſt formidable of ſavage beaſts, the deſpot. For the terrors of deſpotiſm are often exaggerated, and we are to diſtinguiſh between the deſpotiſm of a barbarous and a civilized nation. Nothing can be worſe, indeed, than that deſpotiſm which conducts itſelf, as in Eaſtern governments, by wild fury: but this is owing to ignorance in the people, not to the nature of the government. Enlighten the governors and the governed, give them knowledge, let them have laws and manners, and then I would ſubmit to the monarch, though a deſpot: he might ſometimes abuſe his unlimited authority, but the inſtances would be rare, and the riſque, compared with the dangers of other governments, would be trifling.

The immediate conſequence of this doctrine is, that kings cannot be too much reſpected, nor the ſubjects too much confirmed in the reſpect which is due to them. A little enthuſiaſm in this reſpect will be better than the reſtleſſneſs, diſcontent, and ſeditious ſpirit, which might ariſe from the wantonneſs of liberty: and the moſt dangerous writers are thoſe, who encourage theſe diſpoſitions by endeavouring to erect a tribunal, to which princes ſhould be reſponſible for their actions. There is no other tribunal for them than the publick voice and the judgment of poſterity.

Perhaps it will now be aſked, what has all this to do with a Treatiſe of Elementary Morality? It was neceſſary firſt to lay down the origin of ſociety, and to examine the different forms of government, from which it is not difficult to form a general notion of the whole duty of man. This depends on his knowledge and his ſituation. In both caſes he is dependent; he can have no other knowledge than what is furniſhed by education and his ſtudies, and he cannot have other manners or cuſtoms than thoſe prevailing in the place which gave him birth. And hence we might confine ourſelves to one exhortation. Enlighten yourſelves, as far as circumſtances permit, endeavour to become acquainted with every thing honourable and uſeful, and apply your knowledge to every caſe which admits of the application.

After this there ſhould be a catechiſm of morality varying with the changes taking place in every age. The principles, which may be ſtyled invariable, have been already laid down. Let every one, according to his ſituation, know and act to the beſt of his ability.

But where could one open a ſchool of morality? No one will quit the ſchool of his fathers and his country, to learn maxims that run counter to his prejudices. The world will always remain what it has been ſince it was a world; an aſſemblage of theatres, with each its peculiar decorations, the one ſucceeding the other without ceaſe. Some principles may be laid down, but they will have the ſame ſucceſs as the many books written on the ſame ſubject. The world will go on in its own train, and its melioration depends on a variety of other cauſes.

Be content with your lot, and ſuffer not any reſtleſſneſs or diſcontent to riſe in your minds. The troubles of life proceed from an anxiety not agreeable to nature, which leads us to prefer our own country, our own way of life, our own manners and cuſtoms to any other ſituation. If public calamity ſhould drive you from your country;

try, take every meaſure neceſſary to render your new aſylum peaceful and tranquil. Thoſe, who remain in the country which gave them birth, have from their infancy all the received doctrines inſtilled into them. They are in this reſpect purely paſſive, and if they want a precept, it may be this: Hear, retain, practiſe. How can it be expected that any one ſhould undertake the reviſion of what has been taught him? Why ſhould he break the bonds of ſocial life to propoſe innovations, for which he will be accounted either mad or ſeditious? Proſelytiſm is ſeldom of good alloy, and the Reformation, though authorized by papal tyranny, was, properly ſpeaking, a revolt. Whoever wiſhes to paſs his life agreeably in any place whatſoever, without hatred or contempt, need only attend to the general precept, Do not to another what you would not ſhould be done to you.

To this maxim may be ſubjoined three others.

1. Remember your perfectibility. This is the diſtinct character of man, forming an eternal barrier between him and the brute creation. In oppoſition to this, men are very early taught to be content at a fixed point; parents tell their children, that they are amiable, ſkilful, clever, from whence is formed a habit of indolence and diſſipation. On the contrary, we ſhould exhort them conſtantly: Loſe not to-day, make ſome progreſs, march forward with courage and conſtancy. You cannot acquire too much knowledge, or too much ſkilfulneſs, provided they relate to the duties of your ſtation. I may add, that whoſoever makes a proper uſe of his time, and knows no other recreation than the change of employment, may, after the duties of office, have leiſure for particular ſtudies, and domeſtic concerns.

2. Make the utmoſt uſe poſſible of your faculties. This precept regards firſt thoſe who have the care of youth from early life to manhood. They ſhould diſcover the faculties of the young people, and direct them properly. But how is this great concern neglected! The firſt part of education is mere play, the child is the puppet: at ſchools and colleges they are ſtill more injured, and ſent into the world vapid or ſtupid characters; beſides, their mode of life is fixed without any regard to their talents. One is made a ſoldier, a lawyer, a prieſt, when he ought to have been a painter, a merchant, or a carpenter. But what remedy can be applied? The parents in general have neither ſufficient diſcernment, nor inclination to do better. We are overwhelmed with plans of education, and ſyſtems of government, which do not change the face of things, and which, in fact, could not change it for the better. We only throw the carriage, that is overturned, to the other ſide.

3. The third maxim is: Let there be no egotiſm. That is, let no one ſeek his own advantage at the expence of another. How different is the ſtate of ſociety! In almoſt every employment one begins, as in gaming, by being a dupe, and ends in being a knave. A man of acknowledged rectitude is a phenix, but unfortunately admiration does not produce imitation. We may doubt whether there ever was a golden age, but the preſent is clearly an alloy of the vileſt metals; and inſtead of Aſtræa, the Furies ſeem to rove unchained about the earth. The wiſe man laments over ſuch a ſtate; but in his wiſdom finds the ſource of an interiour calm, which is a perpetual feaſt; he endeavours to diminiſh the maſs of evil, and augment that of good; and the farther he advances in his career, the more he bleſſes the author of his being for not giving him all that he deſired, but for giving him the faculty of enjoying all that was beſtowed upon him.

On the Reality and Ideality of the Objects of our Knowledge. By Mr. SELLE.

MR. Selle, in inveſtigating this ſubject, controverts the philoſophy or rationaliſm of Mr. Kant, a ſyſtem, which has many followers in Germany, but is not likely to be introduced ſoon into, or ever to be much followed in England. The principles of the two philoſophers are beſt ſeen in the comparative view given of them at the end of this memoir.

Rationaliſm.	*Empiriſm.*
1. There is no knowledge purely objective, becauſe objects are given us only by means of the ſenſes, as phænomena: but there is knowledge purely ſubjective, becauſe we poſſeſs ſome neceſſary truths, which experience can never furniſh.	1. Our knowledge is neither purely objective nor purely ſubjective. The repreſentative faculties are given us only by the mean of objects, which produce their phænomena. Truths abſolutely neceſſary are identical truths only.
2. The repreſentations of pure ſpace and pure time are neceſſary and univerſal intuitions, and conſequently of an origin purely ſubjective. They are the tranſcendant forms of the faculty of perceiving, which are not derived from the objects perceived.	2. The intuitions of ſpace and time are immediately given by experience. The pure repreſentations of ſpace and time are only intellectual notions. Theſe notions are only ſo far neceſſary to us, as we wiſh to repreſent to ourſelves the poſſibility of external and internal objects. They are derived from the intuitions by abſtracting the reality of objects, and their ſenſible qualities.
3. The pure repreſentations of quantity, quality, relation, and modality are purely ſubjective notions; becauſe we attribute them univerſally and neceſſarily to objects of intuition, which experience cannot teach us. They are the tranſcendant categories of the faculty of thinking, or the forms of intelligence under which we repreſent to ourſelves mediately intuitions.	3. The repreſentation of an object would be null, if it did not contain at the ſame time the character by which it repreſents an object to us. It is intuition which gives us both one and the other. It is neceſſary that the repreſenting character ſhould agree with the object repreſented. But it is by identity that we acknowledge this neceſſity, which, conſequently, does by no means prove the independence of the character on its object. We ſeparate them by repreſenting them mediately, we reunite them by their intuition.

We

4.

We judge, that a connection is neceſſary, as far as the predicate is the ſame thing as its ſubject, or is a part of it. It is a judgment after the principle of identity, an analytical judgment. There are connections, which we judge abſolutely neceſſary, without the predicate being found by analyſis in the ſubject. The principle of contradiction does not contain the reaſon ſufficient for it. We muſt add the intuition of the ſubject which furniſhes the predicate. The judgment becomes by that a ſynthetical judgment. An empirical intuition does not offer any thing neceſſary: we muſt have intuitions purely ſubjective and independent of experience, to form, a priori, a ſynthetical judgment. And thus the exiſtence of theſe judgments proves that of intuitions purely ſubjective.

5.

Intuitions and notions abſolutely neceſſary and univerſal, have not an objective reality except in applying them to objects of experience. By themſelves, and in applying them to objects purely intellectual, we can attribute to them only a reality purely ſubjective. The idea that a noümenon exiſts really without us or in ſpace, has no objective reality.

4.

It is certain that a ſynthetical judgment is not derived immediately from the principle of contradiction; becauſe it is only by that that it differs from an analytical judgment. Experience alone gives the principle of the firſt, and there are no ſynthetical judgments abſolutely neceſſary. The neceſſary connection of two repreſentations is only ſo far poſſible, as one is found repreſented by the other. If it is the ſubject, whoſe notion contains that of the predicate, the identity is inconteſtable. But what is the reaſon of a connection abſolutely neceſſary between a predicate and its ſubject, when the notion of the predicate makes no neceſſary part of the notion of the ſubject? The reaſon is plain, becauſe it is in a contrary ſenſe in the predicate, that we find the ſubject. Theſe judgments are not therefore ſynthetical, becauſe it is by analyſis we find their identity. They do not ſuppoſe any other principle than that of contradiction, and they do not by any means prove the exiſtence of intuitions purely ſubjective.

5.

The pure repreſentations of ſpace and time, and the categories of objects are applicable to the noümena as far as they contain nothing ſenſible. It is true, that this purely intellectual knowledge of the noümena can be only negative. But a negative knowledge may have an objective reality. Now the exiſtence of the noümena is given by experience, which without that would be impoſſible, and there is not a doubt that we might be able to mark them by negative characters. A noümenon is really in ſpace inaſmuch as it is the neceſſary condition of an external phænomenon, although it is impoſſible to know how it is there.

Tran-

6.

Tranſcendant objects have in conſequence only an ideal objectivity, and the ſyſtem of rationaliſm leads to a tranſcendant idealiſm, though it guarantees empirical realiſm.

7.

Independent of theſe repreſentations purely ſubjective, which lead us to a tranſcendant idealiſm, we have ſome abſolutely neceſſary wants, which conſtrain us to believe, that the neceſſary conditions of experience, which reaſon alone can teach us, have an objective reality. Theſe wants are determined by univerſal and neceſſary laws, and conſequently purely ſubjective, to which there would be no poſſibility of being conformed, without the ſuppoſition, that what the faculty of knowing repreſents only as original modifications, and excluſively proper for our ſoul, exiſt, however, really without us.

6.

Empirical realiſm is in no danger, becauſe common ſenſe provides for it. With the principles and laws of the tranſcendant realiſm, it is of more importance for us to be acquainted.

If by tranſcendant realiſm was underſtood the exiſtence of objects, of which we could obtain a knowledge independent of all experience, this realiſm would be a chimera. If we call tranſcendant realiſm the objectively real exiſtence of noümena, inaſmuch as they are the neceſſary conditions of phænomena, it is the only true conſiſtent and applicable ſyſtem.

7.

It is certain that the tranſcendant idealiſm of objects of experience would ſet us in contradiction with ourſelves. This ſuffices for its refutation. But the reaſons which the rationaliſt oppoſes to it only diſguiſe it: it appears again under another form, and there is only a difference of words. A reaſon purely ſubjective of the reality of an object is none at all. For an object to exiſt really, it muſt exiſt independently of the ſubjective faculty of its repreſentation: without that the objectivity can be only ideal. We muſt look for the ſufficient reaſon of objective reality in the ſubjective faculty of knowing, and the objective faculty of objects. A repreſentation objectively real can be only the reſult of the action and reaction of a tranſcendant repreſentative faculty, and of a tranſcendant repreſentative object. This ſimple truth removes all difficulties, agrees with the laws of our knowledge and actions, and recalls wandering and uncertain ſpeculation to the ſure and ſolid aſſiſtance of common ſenſe.

Upon

8.

Upon theſe principles we gain a ſure and ſolid baſe for all our knowledge and actions, becauſe reaſon, in drawing from the purely ſubjective ſources of our faculties, gives us the univerſal and abſolutely neceſſary laws, for the objects of our repreſentations, and the end of our actions. This autonomy, this independence of objects and external ends, gives the true claim to excellence, ſetting us above experience, which can never furniſh other than particular and contingent rules, calculated upon inductions, always imperfect and uncertain.

8.

Pure reaſon judges abſolutely only of the identity and contradiction of repreſentations; but it deduces nothing from itſelf, the principle of contradiction is the only law which it gives us. It requires on this principle, that our knowledge and actions ſhould not be contradictory, and that they ſhould agree with each other, becauſe it is a neceſſary and univerſal condition of their exiſtence, which would be otherwiſe impoſſible. But it is incapable of deciding by itſelf of this exiſtence, of which it recognizes only the condition. Now the neceſſity of the condition of an exiſtence is a very different thing from the neceſſity of the exiſtence itſelf. The firſt always ſuppoſes the ſecond, and the modality of the latter does not follow immediately the modality of the former. We muſt have therefore abſolutely other principles, and other laws, by which we may judge of the neceſſity of our knowledge and actions. Theſe laws can proceed only from experience, which is the only ſure and ſolid baſe for every thing which reaſon teaches us. Whilſt rationaliſm ſuppoſes purely ſubjective and tranſcending repreſentations, it has not proved them. Whilſt it gives us the principle of contradiction as the firſt neceſſary law of all our knowledge, and all our actions, it teaches us a thing acknowledged immediately and mediately by the whole human race. If laſtly it would deduce from the principle of contradiction other laws than thoſe of identity, it contradicts itſelf. By deducing all our intellectual repreſentations from experience, by admitting no other principle of neceſſity than that of contradiction, and by connecting different intellectual notions in an intuitive unity, the rationaliſts and empiriſts, the idealiſts and realiſts, find a point of re-union, from which they have all equally wandered. I have only indicated this point, and muſt wait till the enlightened philoſophers of our days either prove its falſity, or complete its demonſtration.

An Analyſis of the Principles of Ariſtotle on Government, with Obſervations. By Mr. Bitaube'. *Firſt Memoir.*

THE analyſis is of the firſt book of Ariſtotle, and in the obſervations are remarks upon Rouſſeau, Monteſquieu, Smith, and other political writers. As they have not any novelty to recommend them to an Engliſh reader, an attempt to abridge them is unneceſſary.

On Literary Miſtakes. By Mr. Erman.

IN this memoir, which is to be followed by others on the ſame ſubject, ſome of the miſtakes are recounted, into which literary men have fallen, either from want of acquaintance with the ſciences to which they allude, or ſufficient attention to the language and manners of foreign countries. Some are owing, indeed, to inadvertence, not ignorance, as when Saumaiſe, in a work of great erudition, makes Jeruſalem the place of our Saviour's birth, or Scaliger makes the weight of the Coloſſus at Rhodes 144 inſtead of 7200 quintals. But it was ignorance which turned the univerſity of Altdorf into Mr. Altdorfius, in a French author; and a French journaliſt, by confounding the titles of two of Leſſing's plays "Der Schatz" and "Minna von Barnhelm," made only one, entitled The Treaſure and Mine of Barnhelm. The Germans have not always been more ſucceſsful; for one has tranſlated "La Femme Juge & Partie," Die Frau Richterin iſt abgereiſet. The judge's wife is gone on a journey.

A German writer tranſlates theſe lines,

> Qu'un monarque abſolu, par des arrets tres ſages,
> Proſcrivant les moineaux qui pillent ſes villages—

An abſolute monarch, by wiſe commands, baniſhes the monks which plunder his villages. The mode of pronunciation alſo introduces ſimilar errors. Thus Dr. Sharpe aſked a learned German, at Leipſick, "Suntne omnia pacata in Germania?" who replied with a ſlight degree of acrimony, "Sunt quidem multa peccata in Germania, ſed ſpero plures adhuc virtutes." Similar miſtakes muſt have occurred frequently to every reader, and it is the intention of this writer to ſhew the influence which they have had on the ſciences, and the opinions of mankind. Many of them will be found to be of very great importance.

Three Memoirs of Count HERZBERG: *the firſt to prove, that the Pruſſian Government is not deſpotical.* 2. *On Hereditary Nobility.* 3. *On the Revolutions of States.*

THE firſt is not likely to convince an Engliſh reader; and if it ſuits the inhabitants of Berlin, the Count's purpoſe is anſwered. There is at the end a liſt of the benefactions of the king to his ſubjects in the year 1789, which proves, that his Majeſty is anxious for the welfare of his country. They amount to 2,860,700 crowns, which are beſtowed for the amelioration of lands, public buildings, defence from inundations, encouragement of manufactures, and other uſeful purpoſes in various parts of his territories.

The ſecond is chiefly an encomium on the Pruſſian nobility, which is repreſented as the ſupport of the army, and conſequently the empire.

The third gives a curſory view of the revolutions that have taken place in various ages of the world. From the connection now formed between Pruſſia and Poland, it may gratify our readers to hear the Count's remarks on the revolution that had lately been compaſſed in the latter kingdom. "The Poliſh nation, excited, no doubt, by the example of the French, has lately given a new example of a revolution, executed with more order and moderation, and which may render this nation and its conſtitution as happy as its local ſituation permits, if it purſues it and makes uſe of it with the ſame moderation and wiſdom, within and without, which gave riſe to it, and ſet it in motion."

On the Hiſtory of Brandenburgh during the middle Ages, and the Light thrown on it by cotemporary Coins.

THE hiſtory of Brandenburgh, during the dark ages, is obſcure from the nature and ſcarcity of records, which conſiſt chiefly of regiſters of convents, and from the want of ſufficiently diſtinctive marks in the coins. The latter can, by attention, be in great meaſure removed; and the author recommends a more accurate inveſtigation of the ancient coins of the country, which, though from the inferiority of workmanſhip, not attended with the ſame pleaſure as the ſtudy of the Greek and Roman coins, is, from the light which they will occaſionally throw upon hiſtory, deſerving of encouragement.

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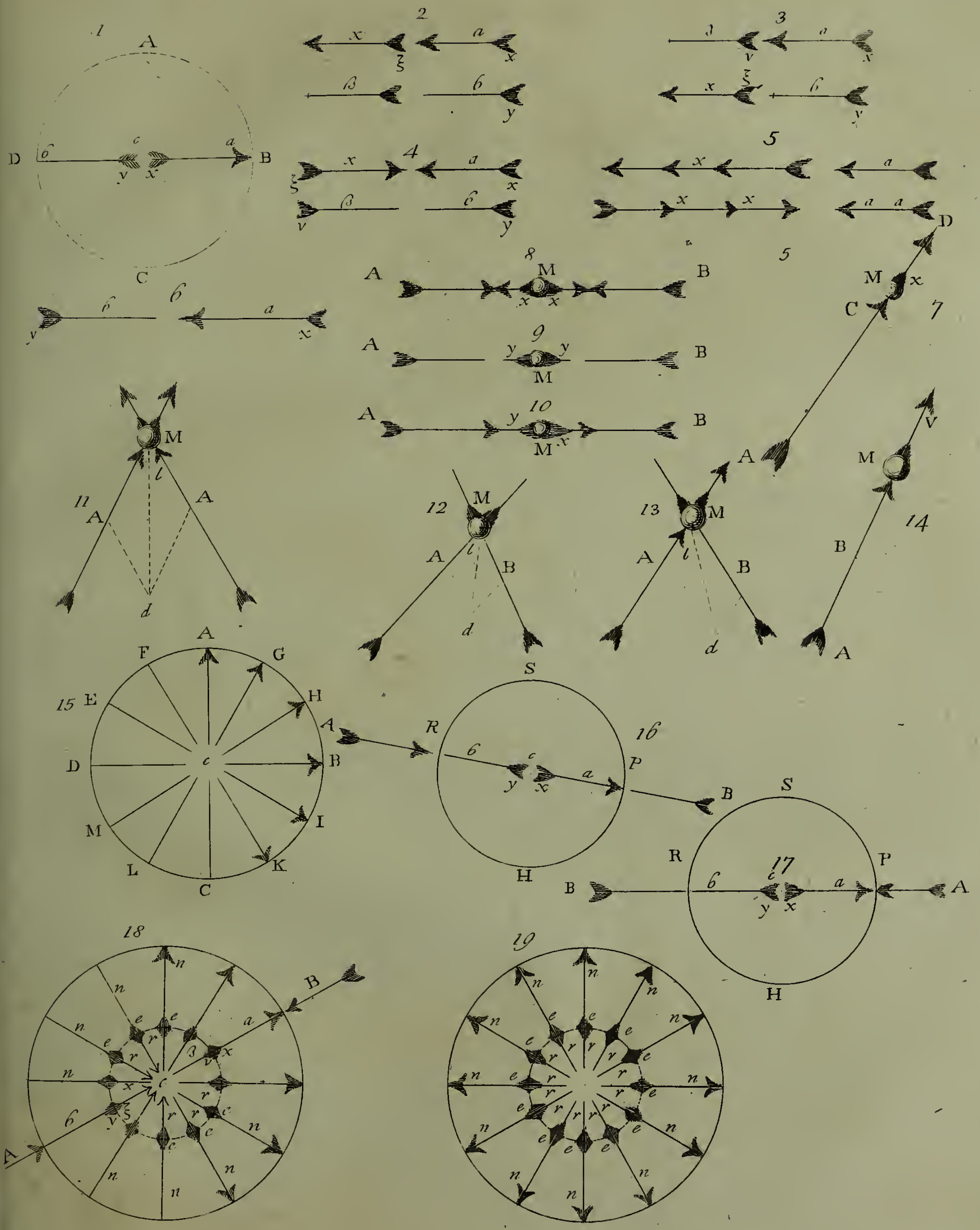
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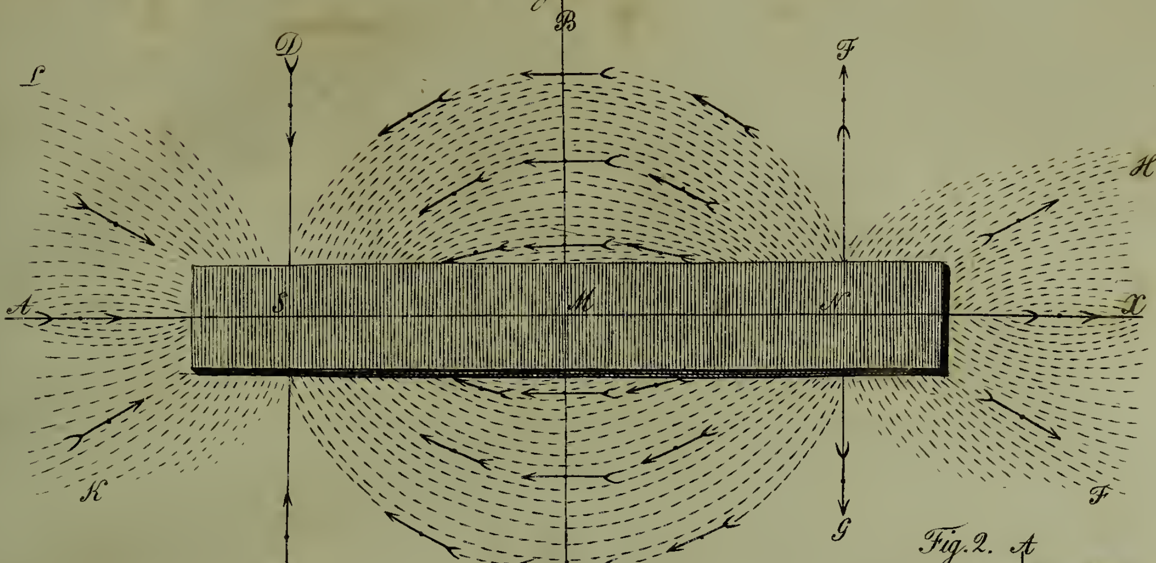

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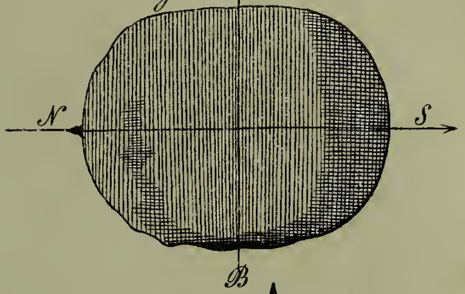

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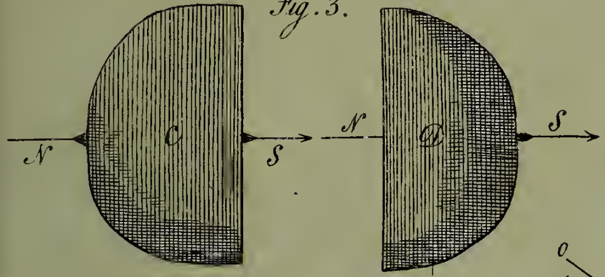

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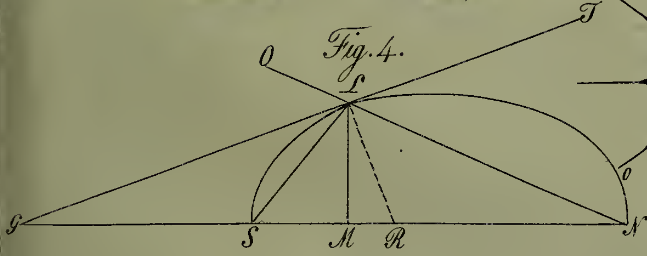

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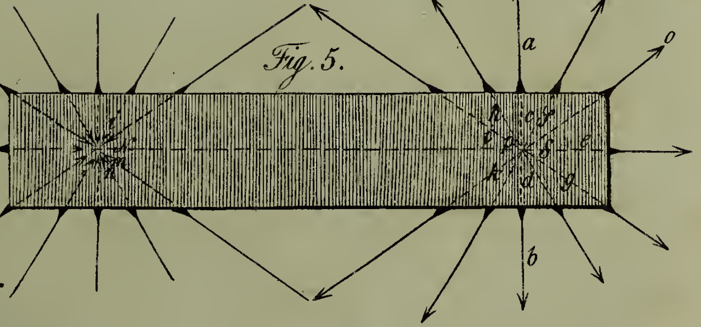

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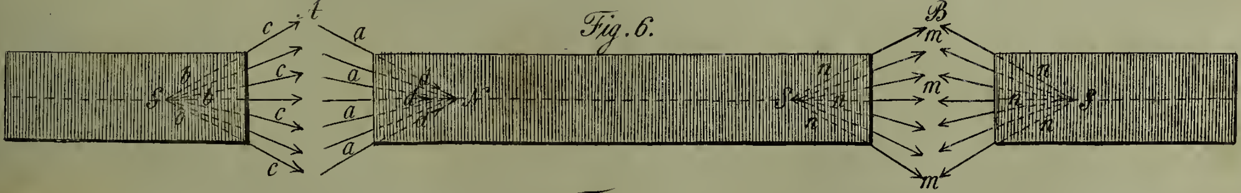

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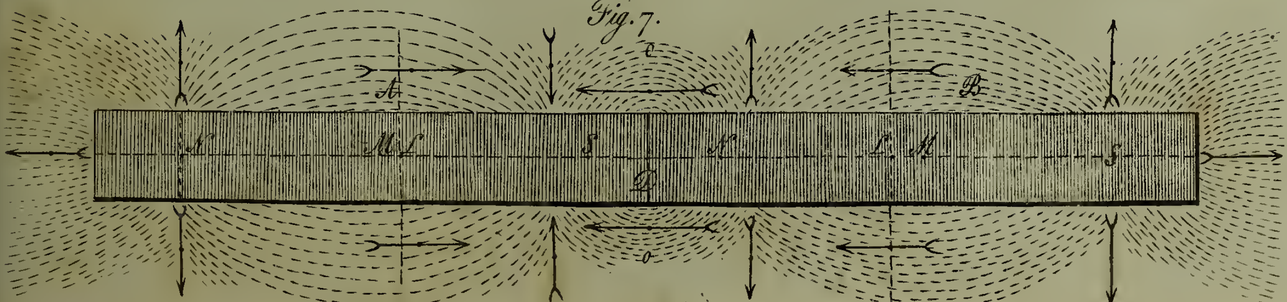

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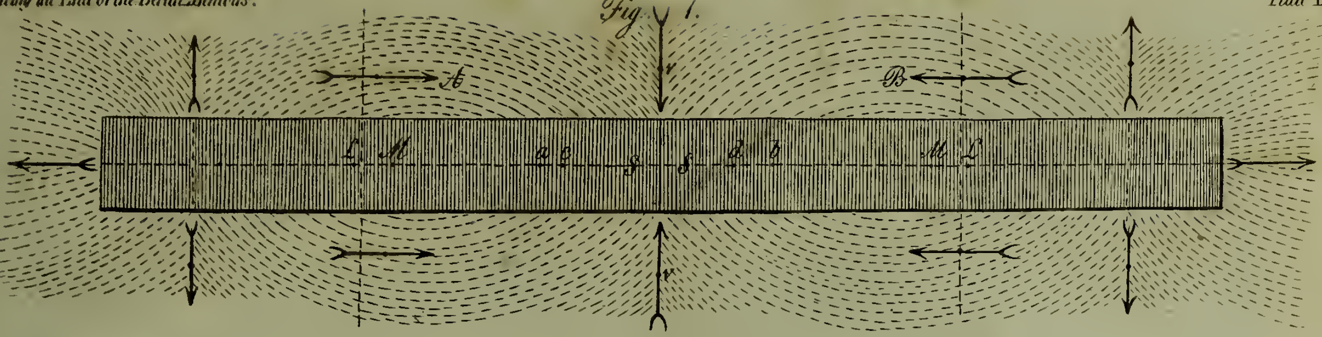

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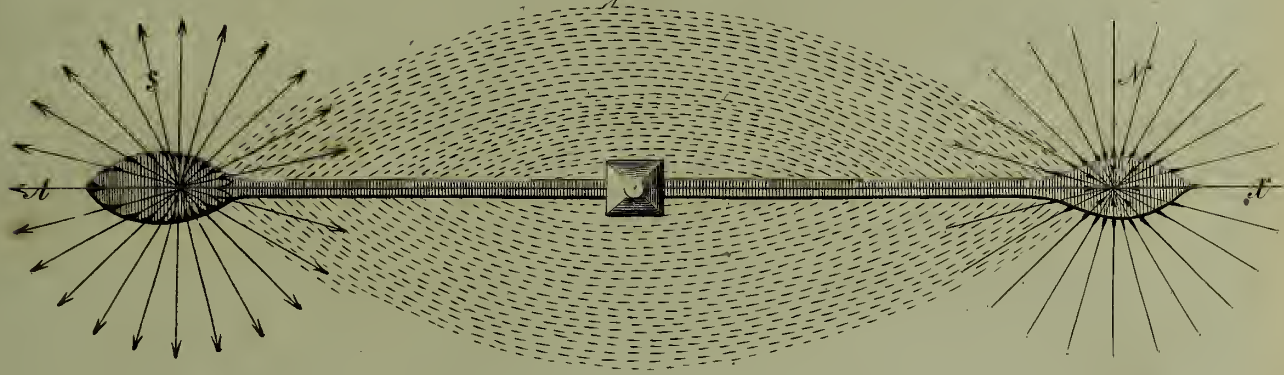

Fig. 4.

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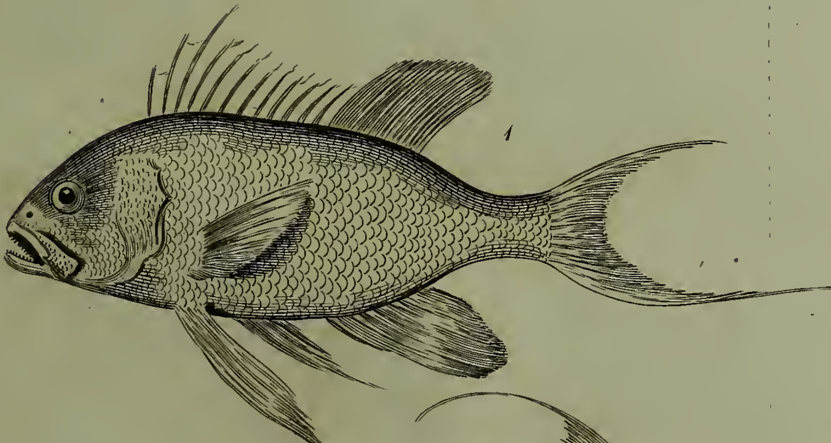

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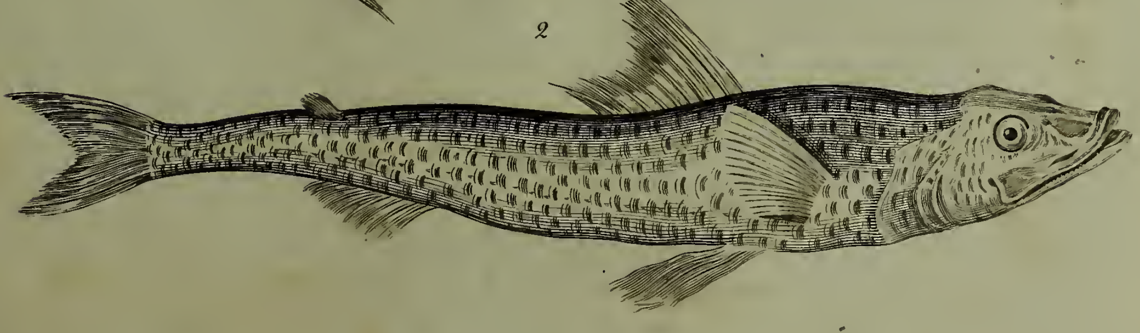
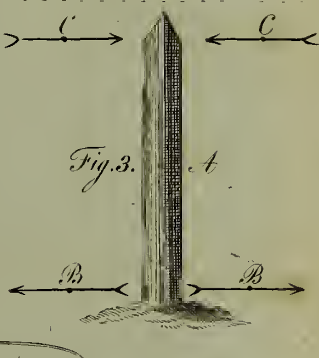


Fig. 3.



Hixon sculp.

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APPENDIX

MEMOIRS

OF

SCIENCE AND THE ARTS.

NUMBER I.

Supplement to the Account, of Mr. Burrow's Paper on Friction in Mechanics. Page 18.

THE figures of the plate from 1 to 9 are all reſpecting the inclined plane, and bear the ſame deſcription and reference as given of 1, 2 and 3 in page 18, except 7 and 9. In Fig. 7 A*hq*N is the ſegment of an equilateral triangle generating a ſolid round its axis BC $\therefore$ GEHK a figure moving thereon and touching it on all ſides as at *qp*. Then let P be the center of gravity of one half of the body and PR its weight, if PD*n* be $\perp$ to AB and R*n* $\parallel$ to AC, P*n* will be the preſſure againſt A*h*, and the friction the n part of P*n*.

In all the former propoſitions the plane AB is ſuppoſed to be a right line, but in Fig. 9. it is repreſented by the curve MAHG and as the friction on the horizontal plane is as the ſum of the preſſures, it is alſo as the ſum of all the elementary lines MR or PN, that is as the area AHNP, and the friction on the curve is for the ſame reaſon as the ſum of all the RF or PQ or as the area APQG.

In Fig. 10 M*m*AQ is a convex ſolid generated on the axis AP, and MRSQ a concave exactly fitting it, then if this body be revolved about AP, the force neceſſary to overcome the friction may be found as follows. Admit the concave MRSQ, compoſed of an infinity of concentric circles, or tubes, alſo let the ordinates PN of the curve HN repreſent the preſſure of each ſmall part M*k*, or elementary line at the diſtance PM from the axis, and let *c* be the circumference of a circle whoſe radius is unity. Then becauſe the friction is as the preſſure, and the preſſure is as the number of lines M*k*, therefore $(\mathrm{PM}.\mathrm{M}n.c):n$ will be the force neceſſary acting at M to overcome the friction, but as the preſſure of each elementary part is increaſed in the ratio of M*n* to M*m*, when moved on the ſolid MAQ the real force when acting at *f*, will be the fluent of $(\mathrm{PM}^2\,\mathrm{PN}.\mathrm{M}m.c):(n,\mathrm{P}f)$.

This ſolution applies to the nature of the ſcrew.

Let BD Fig. 11 be an upright cylinder, and AB a body touching it in a line as in the figure, and retained cloſe to it by an imaginary force drawing it perpendicular towards the axis: then if a force CP be applied to C the center of gravity of AB, and be always ſuppoſed to act perpendicularly to the radius CN drawn from the center of the axis to the point C, the friction will be the ſame in drawing the body round the cylinder, as in drawing it along a horizontal plane with an equal preſſure; and if it be moved round by a force acting at a greater diſtance, the force will be reciprocally as the diſtance; on the contrary if the body AB be fixed, and the cylinder turned round about its axis, the friction will be the ſame as if the cylinder was fixed, and the body drawn round it by CP as before: Likewiſe the friction is the ſame, whether the cylinder be fixed and the body AB moved round the axis MR by a force Q*c* applied at *c*; or whether the point *c* be fixed with AB faſtened to C*c*, and the cylinder be revolved in a circle whoſe center is *c*, ſo as always to retain its paralleliſm with reſpect to any fixt object; and as this laſt caſe obtains in the axletrees of carriages, ſince every point of the wheel's contact with the ground may be conſidered as the center of motion for that inſtant, therefore the effect of the reſiſtance ariſing from the friction of the concave part of the nave upon the axletree, is to the effect that would ariſe from drawing the ſame weight over a horizontal plane of the ſame kind as the parts that rub each other, as the radius of the axis, to the radius of the wheel: It muſt be obſerved that this is not the only friction to which carriages are ſubject, for there is another part ariſing from the cohesion of the wheel and the ground at their contact, which is to be found and allowed for by the three firſt propoſitions.

Let M be a weight placed at the point A of a lever moveable about an axis whoſe center is *d* and radius *dn*; and let N be the ſuſtaining force acting at B: Now it is evident that the preſſure on the axis d, differs ſo little from the weight that it may be ſafely taken for it without any conſiderable error, except in ſome remarkable caſes which may be allowed for from what has been ſaid already; and therefore the friction which ought in ſtrictneſs to be taken as the *n* part of the preſſure, will here be taken as the *n* part of the weight upon the axis: Now if N be taken for the force which acting at B would be juſt ſufficient to keep the weight M at A, in equilibrio, excluſive of friction; and if W be the additional force to be added to N ſo as to overcome the friction; then will M+P, M—P, and P—M, be the weight upon the axis at *d* in the firſt, ſecond, and third figures reſpectively (ſuppoſing the ſum of M and N to be equal to P); now as the friction is the *n* part of each of theſe quantities, and its effect is to keep the lever in a ſtate of reſt; therefore in whatever direction the force at N endeavours to draw the lever by acting at B, the friction tends to counteract that force by keeping the lever ſteady or acting in a contrary direction at *n*; and as the effect of the friction, and the additional force W, are in equilibrio; and the friction acts by means of the lever *dn*, and the force W by the lever *d*B; therefore B*d* is to *dn*, as the ſum or difference of the *n* part of *N*+*W* and *M*, is to *W*; conſequently

$W = dn\ (M+N) : (n.Bd-dn)$, in the firſt figure; $W = dn\ (M-N) : (n.Bd+dn)$, in the ſecond figure; and in the third figure, $W = dn(N-M) : (n.Bd-dn)$: all theſe are the expreſſions for the moving forces.

Fig. 15 and 16 Mr. Burrows makes uſe of to explain the nature of the wedge, where AC is the force neceſſary to ſuſtain the wedge, (Fig. 15) QPB friction included, and AB the force excluſive of friction; draw AN and AH ⊥ to BQ and BP alſo CG and CF ∥ to AN and AH: Now GA and AF the forces of the wood againſt the ſide of the wedge in thoſe directions, compound a force equal to CA in the direction CA, therefore a force equal to AC muſt be applied to the head of the wedge at *a*, to overcome theſe forces.

This being the ſame as a key ſtone to an arch, Mr. Burrows alſo applies it to determine the neceſſary ſtrength of arches, to ſuſtain certain weights, and alſo by Fig. 16 to aſcertain the force neceſſary to break an arch upwards.

The concluſion of the paper is a long commentary on an Italian author, who objects to dividing the force AB into two forces AN and AH, but here Mr. Burrows demonſtrates ab. Abſurdum that P. Friſi's, objection is groundleſs. Fig. 17, is for this purpoſe copied from the Italian author.

NUMBER II.

References to Plate IX. *Fig.* 4. *Of the Lacſha or Lac Inſects.*

No. 1. The female inſect in its *larva* ſtate.
2. The egg which produces the male.
3. The male inſect.
4. The head with jointed antennæ.
5. The wings on one ſide.

The preceding figures are much magnified, but in juſt proportion.
6. A piece of Lac, of its natural ſize.
7. The inſide of the external coat of the cells.
8. One of the utriculi.

The two laſt figures are a little magnified.

APPENDIX

[illegible]

MEMOIRS
OF
SCIENCE AND THE ARTS.

III. *On the Cauſes which affect the Accuracy of Barometrical Meaſurements.* By J. PLAYFAIR, *M.A. &c.* *Page* 284.

THE object of this paper is to correct the errors ariſing from various circumſtances affecting the denſity of the atmoſphere, whether from the temperature of the air, the expanſion from various degrees of heat, the denſity not being exactly as the compreſſing force, and the force of gravity not being uniform. Let H be the heat at the ſurface of the earth, and b the leaſt heat at height a, the heat at height x is $H-\frac{(H-h)}{a}x$. Suppoſe air of given temperature 32° by the loſs of one degree, contracted $\frac{1}{411}$ or part m of its bulk. Its bulk in temperature 31° is $1-m$. By the loſs of another degree, its contraction is $m\,(1-m)$, which ſubtracted from $1-m$, gives its bulk in temperature 30° $(1-m)^2$. Let b be the heat of a given quantity of air, then $\overline{1-m}^{32-b}$ is the ſpace occupied by the air, ſuppoſing the compreſſing force always given. Let the expanſion for a certain degree of heat be as a certain power of the compreſſing forcer μ, m being the expanſion for one degree of heat when the mercury is at the height b, then the expanſion for any height β will be $\frac{\beta^\mu}{b^\mu}m$, and the ſpace occupied by the air, $\left(1-\frac{m\beta^\mu}{b^\mu}\right)^{32-h}$.

Let y = denſity of air at height x above the earth's ſurface, H = heat at the ſurface, expreſſed in degrees of Fahrenheit's thermometer, λx = difference of degrees at the ſurface and height x, then temperature at height $x = H-\lambda x$, let m = expanſion of a given quantity of air, occupying ſpace 1, in temperature 32°, for one degree

of

of heat; ſetting aſide the inequality of expanſion depending on preſſure, the ſpace occupied by the ſame quantity of air of temperature, $H - \lambda x = (1-m)^{32-H+\lambda x}$ or if $\tau = 32 - H$, it $= (1-m)^{\tau+\lambda x}$.

Now let this quantity of air, bulk $= 1$, and temperature $= 32°$, be compreſſed by a column of air of the ſame denſity and temperature, but of the height p; then $-\int y\dot{x}$ being compreſſing force or weight of ſuperincumbent atmoſphere at height x, we have $1 : y :: p : \dfrac{-\int y\dot{x}}{(1-m)^{\tau+\lambda x}}$ and $y = \dfrac{-\int y\dot{x}}{p\,(1-m)^{\tau+\lambda x}}$.

The inequalities depending on the force of gravity and the compreſſing force are not here conſidered.

Since $y = \dfrac{-\int y\dot{x}}{p(1-m)^{\tau+\lambda x}}$, we have $py\,(1-m)^{\tau+\lambda x} = -\int y\dot{x}$, and $p\dot{y}\,(1-m)^{\tau+\lambda x} + p\lambda y\,(log.\ 1-m)\,(1-m)^{\tau+\lambda x}\,\dot{x} = -y\dot{x}$, or, $\dfrac{p\dot{y}}{y} + p\lambda\,log.(1-m)\,\dot{x} = -(1-m)^{\tau+\lambda x}$.

Hence, making $log.\ (1-m) = g$, $\dfrac{p\dot{y}}{y} = -p\lambda g\dot{x} - \dfrac{\dot{x}}{(1-m)^{\tau+\lambda x}}$, and $p\ log.y + p\ log.C = -p\lambda gx + \dfrac{1}{\lambda g\,(1-m)^{\tau+\lambda x}}$.

If D denote the denſity of the air at the ſurface of the earth, D will be the value of y, when $x = 0$, and ſo $p\,(log.\ D + log.\ C) = \dfrac{1}{\lambda g\,(1-m)^{\tau}}$. Therefore $p\ log.\ C = \dfrac{1}{\lambda g\,(1-m)^{\tau}} - p\ log.D$; and ſo by ſubſtituting for $p\ log.\ C$, $p\,(log.\ y - log.\ D) + \dfrac{1}{\lambda g\,(1-m)^{\tau}} = -p\lambda gx + \dfrac{1}{\lambda g\,(1-m)^{\tau+\lambda x}}$; or changing the ſigns, $p\,(log.\ D - log.\ y) - \dfrac{1}{\lambda g\,(1-m)^{\tau}} = p\lambda gx - \dfrac{1}{\lambda g\,(1-m)^{\tau+\lambda x}}$.

This equation gives the relation of the denſity and height of any ſtratum of air, ſuppoſing the heat to decreaſe uniformly, and that ſpace occupied by air of heat $h = (1-m)^{32-h}$.

Let us now ſuppoſe that z is the whole height to be meaſured, and that Δ is the denſity at that height, the temperature there being alſo found $= h$, by obſervation. If then x become $= z$, and $y = \Delta$, we will alſo have $\lambda z = H - h$, and $\tau + \lambda z = 32 - H + H - h = 32 - h = r - h$, making $r = 32$. Alſo $\lambda = \dfrac{H-h}{z}$. Therefore, by ſubſtituting theſe values of y, x, λ, and $\tau+\lambda z$, in the preceding equation we have,

$$p\,(log.\ D - log.\ \Delta) - \frac{z}{g\,(H-h)\,(1-m)^{\tau}} = pg\,(H-h) - \frac{z}{g\,(H-h)\,(1-m)^{r-h}}.$$

Hence, by tranſpoſition, &c. $gp\,(H-h)\,(log.\ D - log.\ \Delta - (H-h)\,g) = z\left((1-m)^{H-r} - (1-m)^{h-r}\right)$; and $x = \dfrac{gp\,(H-h)\,(log.\ D - log.\ \Delta - (H-h)\,g).}{(1-m)^{H-r} - (1-m)^{h-r}}$

Let b be height of mercury in the lower, and β that of the higher barometer; and ſince b is the compreſſing force at the ſurface of the earth, $D = \frac{b}{(1-m)^{r-H}}$; and, for a like reaſon, $\Delta = \frac{\beta}{(1-m)^{r-h}}$. Therefore, $\log. D = \log. b - (r-H)\,g$, and $-\log. \Delta = -\log. \beta + (r-h)\,g$. Hence $\log. D - \log. \Delta = \log. b - \log. \beta + (H-h)\,g$, and ſubſtituting for $\log. D - \log. \Delta$ in the formula of the laſt ſection.

$$z = \frac{gp\,(H-h)\,(\log. b - \log. \beta)}{(1-m)^{H-r} - (1-m)^{h-r}}.$$

For the convenience of computation and compariſon with the formula now in uſe, $\frac{1}{(1-m)^{H-r} - (1-m)^{h-r}}$ muſt be reduced into a ſeries. $\frac{1}{(1-m)^{H-r} - (1-m)^{h-r}} = \frac{(1-m)^r}{(1-m)^H - (1-m)^h}$ and g being the logarithm of $1-m$.

$(1-m)^H = 1 + Hg + \frac{H^2 g^2}{2} + \frac{H^3 g^3}{6} + \&c.$ And $-(1-m)^h = -1 - hg - \frac{h^2 g^2}{2} - \frac{h^3 g^3}{6} - \&c.$ Therefore $\frac{(1-m)^r}{(1-m)^H - (1-m)^h}$

$$= \frac{1 + rg + \frac{r^2}{2} g^2 + \frac{r^3}{6} g^3 + \&c.}{(H-h)\,g + \frac{H^2-h^2}{2} g^2 + \frac{H^3-h^3}{6} g^3 + \&c.} \text{ and } \frac{g\,(H-h)\,(1-m)^r}{(1-m)^H - (1-m)^h} =$$

$$\frac{1 + rg + \frac{r^2}{2} g^2 + \frac{r^3}{6} g^3 + \&c.}{1 + \frac{H+h}{2} g + \frac{H^2+Hh+h^2}{6} g^2 + \&c.}.$$

$$\text{Hence } z = p\,(\log. b - \log. \beta)\left(\frac{1 + rg + \frac{r^2}{2} g^2 + \frac{r^3}{6} g^3 + \&c.}{1 + \frac{H+h}{2} g + \frac{H^2+Hh+h^2}{6} g^2 + \&c.}\right).$$

When m and g are very ſmall, and H and h do not differ much from r, as in the caſe of uniform expanſion, we may reject all the powers of g but the firſt, and ſuppoſe $g = -m$.

$$\text{Then } z = p\,(\log. b - \log. \beta)\left(\frac{1-rm}{1 - \frac{H+h}{2} m}\right), \text{ or } z = p\left(1 + \left(\frac{H+h}{2} - r\right)m\right)(\log. b - \log. \beta).$$

This laſt formula, when the proper values are given to p, r, m, is preciſely the ſame that was diſcovered by De Luc, without any enquiry into the propagation of heat through the atmoſphere.* If the heat diminiſhes in ſome ratio of the height ſo as to be expreſſed by $H-\lambda x^{n}$, then $z = p\left(1+m\left(\frac{nH+h}{n+1}-r\right)\right)\log.\frac{b}{\beta}$, the fixt temperature r being ſubtracted from $\frac{nH+h}{n+1}$ not $\frac{H+h}{2}$, and this is a formula which conjecture or experiment alone would ſcarcely have diſcovered.

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* In De Luc's rule, improved by later obſervations, $p = 4342{,}9448$ = modules of the tabular logarithms multiplied by 10000, $r = 32°$ and $m = {,}00245$ nearly.

Suppoſing the temperature $\frac{H+h}{2}$ to be uniformly diffuſed through the column of air, whoſe height is to be meaſured, the formula $z = p\left(1+m\left(\frac{H+h}{2}-r\right)\right)\log.\frac{b}{\beta}$ is rigorouſly juſt; but if the heat varies inverſely as the height, the terms of the ſeries after the firſt may be rejected as inconſiderable.

The amount of the terms which are thus rejected comes now to be conſidered; and it will be aſcertained with ſufficient accuracy, if we compute the ſecond term of the ſeries, or that which involves in it m^2. Now,

$$\frac{1+rg+\frac{r^2}{2}g^2+\&c.}{1+\frac{H+b}{2}g+\frac{H^2+Hb+b^2}{6}g^2+\&c.} =$$

$$1+\left(r-\frac{H+b}{2}\right)g+\left(\frac{r^2-r(H+b)}{2}+\frac{H^2+4Hb+b^2}{12}\right)g^2;$$

$$\text{and } g = log.\,(1-m) = -m+\frac{m^2}{2}-\&c.$$

$$\text{ſo that } g^2 = \qquad m^2-\&c.$$

$$\text{Therefore, by ſubſtitution, } \frac{1+rg+\frac{r^2}{2}g^2}{1+\frac{H+b}{2}g+\frac{H^2+Hb+b^2}{6}g^2} =$$

$$1+\left(\frac{H+b}{2}-r\right)m+\left(\frac{r}{2}-\frac{H+b}{4}+\frac{r^2-r(H+b)}{2}+\frac{H^2+4Hb+b^2}{12}\right)m^2.$$

This gives z corrected for the temperature of the air, and the firſt inequality of expanſion. The ſecond term with coefficient m is De Luc's expreſſion, the third term with coefficient m^2 ariſes from the equable decreaſe of heat, and the above-mentioned inequality of expanſion.

To complete the effect of the ſecond inequality of expanſion, let $\frac{H+b}{2}-r=f$, and β be conſidered as variable. Then in formula, $\left(1-m\frac{m\beta^{\mu}}{b^{\mu}}\right)^{32-h}$ let m be the expanſion for 1° degree of heat, when the mercury is at the height γ, and retaining the other denominations as before, we have

$$y = \frac{-fy\dot{x}}{p\left(1+\frac{fm}{\gamma^{\mu}}\beta^{\mu}\right)} \text{ and } py\left(1+\frac{fm}{\gamma^{\mu}}\beta^{\mu}\right) = -fy\dot{x}\ \therefore$$

$p\dot{y}+$

APPENDIX

To VOLUME I. PART II.

OF

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III. *On the Cauſes which affect the Accuracy of Barometrical Meaſurements.*

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THE object of this paper is to correct the errors ariſing from various circumſtances affecting the denſity of the atmoſphere, whether from the temperature or the air, the expanſion from various degrees of heat, the denſity not being exactly as the compreſſing force, and the force of gravity not being uniform. Let *H* be the heat at the ſurface of the earth, and *h* the leaſt heat at height *a*, the heat at height x is $H - \frac{(H-h)}{a} x$. Suppoſe air of given temperature 32° by the loſs of one degree, contracted $\frac{1}{411}$ or part *m* of its bulk. Its bulk in temperature 31° is $1-m$. By the loſs of another degree, its contraction is $m\ (1-m)$, which ſubtracted from $1-m$, gives its bulk in temperature 30° $(1-m)^2$. Let *b* be the heat of a given quantity of air, then $\overline{1-m}^{32-b}$ is the ſpace occupied by the air, ſuppoſing the compreſſing force always given. Let the expanſion for a certain degree of heat be as a certain power of the compreſſing forcer μ, *m* being the expanſion for one degree of heat when the mercury is at the height *b*, then the expanſion for any height β will be $\frac{\beta^\mu}{b^\mu} m$, and the ſpace occupied by the air, $\left(1 - \frac{m\beta^\mu}{b^\mu}\right)^{32-h}$.

Let y = denſity of air at height x above the earth's ſurface, H = heat at the ſurface, expreſſed in degrees of Fahrenheit's thermometer, λx = difference of degrees at the ſurface and height x, then temperature at height $x = H - \lambda x$, let m = expanſion of a given quantity of air, occupying ſpace 1, in temperature 32°, for one degree of heat; ſetting aſide the inequality of expanſion depending on preſſure, the ſpace occupied by the ſame quantity of air of temperature, $H-\lambda x = (1-m)^{32-H+\lambda x}$ or if $\tau = 32-H$, it $= (1-m)^{\tau+\lambda x}$.

Now let this quantity of air, bulk $= 1$, and temperature $= 32°$, be compreſſed by a column of air of the ſame denſity and temperature, but of the height p; then $-\int y\dot{x}$ being compreſſing force or weight of ſuperincumbent atmoſphere at height x, we have $1 : y :: p : \frac{-\int y\dot{x}}{(1-m)^{\tau+\lambda x}}$ and $y = \frac{-\int y\dot{x}}{p\,(1-m)^{\tau+\lambda x}}$.

The inequalities depending on the force of gravity and the compreſſing force are not here conſidered.

Since $y = \frac{-\int y\dot{x}}{p(1-m)^{\tau+\lambda x}}$, we have $py\,(1-m)^{\tau+\lambda x} = -\int y\dot{x}$, and $p\dot{y}\,(1-m)^{\tau+\lambda x} + p\lambda y\,(log.\ 1-m)\,(1-m)^{\tau+\lambda x}\,\dot{x} = -y\dot{x}$, or, $\frac{p\dot{y}}{y}+p\lambda\,log.\,(1-m)\,\dot{x} = -(1-m)^{\tau+\lambda x}$.

Hence, making $log.\ (1-m) = g$, $\frac{p\dot{y}}{y} = -p\lambda g\dot{x} - \frac{\dot{x}}{(1-m)^{\tau+\lambda x}}$; and $p\,log.\,y + p\,log.\,C = -p\lambda gx + \frac{1}{\lambda g\,(1-m)^{\tau+\lambda x}}$.

If D denote the denſity of the air at the ſurface of the earth, D will be the value of y, when $x = 0$, and ſo $p\,(log.\ D + log.\ C) = \frac{1}{\lambda g\,(1-m)^{\tau}}$. Therefore $p\ log.\ C = \frac{1}{\lambda g\,(1-m)^{\tau}} - p\,log.D$; and ſo by ſubſtituting for $p\,log.\ C$, $p\,(log.\,y - log.\ D) + \frac{1}{\lambda g\,(1-m)^{\tau}} = -p\lambda gx + \frac{1}{\lambda g\,(1-m)^{\tau+\lambda x}}$; or changing the ſigns, $p\,(log.\ D - log.\,y) - \frac{1}{\lambda g\,(1-m)^{\tau}} = p\lambda gx - \frac{1}{\lambda g\,(1-m)^{\tau+\lambda x}}$.

This equation gives the relation of the denſity and height of any ſtratum of air, ſuppoſing the heat to decreaſe uniformly, and that ſpace occupied by air of heat $h = (1-m)^{32-h}$.

Let us now ſuppoſe that z is the whole height to be meaſured, and that Δ is the denſity at that height, the temperature there being alſo found $= h$, by obſervation. If then x become $= z$, and $y = \Delta$, we will alſo have $\lambda z = H-h$, and $\tau+\lambda z = 32-H+H-h = 32-h = r-h$, making $r = 32$. Alſo $\lambda = \frac{H-h}{z}$. Therefore, by ſubſtituting theſe values of y, x, λ, and $\tau+\lambda z$, in the preceding equation we have,

$$p\,(log.\ D - log.\ \Delta) - \frac{z}{g\,(H-h)\,(1-m)^{\tau}} = pg\,(H-h) - \frac{z}{g\,(H-h)\,(1-m)^{r-h}}.$$

Hence, by tranſpoſition, &c. $gp\,(H-h)\,(log.\ D - log.\ \Delta - (H-h)\,g) = z\left((1-m)^{H-r} - (1-m)^{h-r}\right)$; and $x = \frac{gp\,(H-h)\,(log.\ D - log.\ \Delta - (H-h)\,g).}{(1-m)^{H-r} - (1-m)^{h-r}}$

Let b be height of mercury in the lower, and β that of the higher barometer; and ſince b is the compreſſing force at the ſurface of the earth, $D = \frac{b}{(1-m)^{r-H}}$; and, for a like reaſon, $\Delta = \frac{\beta}{(1-m)^{r-h}}$. Therefore, $log.\,D = log.\,b - (r-H)\,g$, and $-log.\,\Delta = -\,log.\,\beta + (r-h)\,g$. Hence $log.\,D - log.\,\Delta = log.\,b - log.\,\beta + (H-h)\,g$, and ſubſtituting for $log.\,D - log.\,\Delta$ in the formula of the laſt ſection.

$$z = \frac{gp\,(H-h)\,(log.\,b - log.\,\beta)}{(1-m)^{H-r} - (1-m)^{h-r}}.$$

For the convenience of computation and compariſon with the formula now in uſe, $\frac{1}{(1-m)^{H-r} - (1-m)^{h-r}}$ muſt be reduced into a ſeries. $\frac{1}{(1-m)^{H-r} - (1-m)^{h-r}} = \frac{(1-m)^r}{(1-m)^H - (1-m)^h}$, and g being the logarithm of $1-m$.

$$(1-m)^H = 1 + Hg + \frac{H^2 g^2}{2} + \frac{H^3 g^3}{6} + \&c. \quad \text{And} \quad -(1-m)^h = -1 - hg - \frac{h^2 g^2}{2} - \frac{h^3 g^3}{6} - \&c. \quad \text{Therefore} \quad \frac{(1-m)^r}{(1-m)^H - (1-m)^h}$$

$$= \frac{1 + rg + \frac{r^2}{2} g^2 + \frac{r^3}{6} g^3 + \&c.}{(H-h)\,g + \frac{H^2-h^2}{2} g^2 + \frac{H^3-h^3}{6} g^3 + \&c.} \quad \text{and} \quad \frac{g\,(H-h)\,(1-m)^r}{(1-m)^H - (1-m)^h} =$$

$$\frac{1 + rg + \frac{r^2}{2} g^2 + \frac{r^3}{6} g^3 + \&c.}{1 + \frac{H+h}{2} g + \frac{H^2+Hh+h^2}{6} g^2 + \&c.}$$

$$\text{Hence } z = p\,(log.\,b - log.\,\beta)\left(\frac{1 + rg + \frac{r^2}{2} g^2 + \frac{r^3}{6} g^3 + \&c.}{1 + \frac{H+h}{2} g + \frac{H^2+Hh+h^2}{6} g^2 + \&c.}\right).$$

When m and g are very ſmall, and H and h do not differ much from r, as in the caſe of uniform expanſion, we may reject all the powers of g but the firſt, and ſuppoſe $g = -\,m$.

$$\text{Then } z = p\,(log.\,b - log.\,\beta)\left(\frac{1 - rm}{1 - \frac{H+h}{2} m}\right), \text{ or } z = p\left(1 + \left(\frac{H+h}{2} - r\right)m\right)(log.\,b - log.\,\beta).$$

This laſt formula, when the proper values are given to p, r, m, is preciſely the ſame that was diſcovered by De Luc, without any enquiry into the propagation of heat through the atmoſphere.* If the heat diminiſhes in ſome ratio of the height ſo as to be expreſſed by $H-\lambda x^{n}$, then $z=p\left(1+m\left(\frac{nH+h}{n+1}-r\right)\right)\log.\frac{b}{\beta}$, the fixt temperature r being ſubtracted from $\frac{nH+h}{n+1}$ not $\frac{H+h}{2}$, and this is a formula which conjecture or experiment alone would ſcarcely have diſcovered.

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* In De Luc's rule, improved by later obſervations, $p = 4342{,}9448$ = modules of the tabular logarithms multiplied by 10000, $r = 32°$ and $m = {,}00245$ nearly.

Suppoſing the temperature $\frac{H+h}{2}$ to be uniformly diffuſed through the column of air, whoſe height is to be meaſured, the formula $z=p\left(1+m\left(\frac{H+h}{2}-r\right)\right)\log.\frac{b}{\beta}$ is rigorouſly juſt; but if the heat varies inverſely as the height, the terms of the ſeries after the firſt may be rejected as inconſiderable.

The amount of the terms which are thus rejected comes now to be conſidered; and it will be aſcertained with ſufficient accuracy, if we compute the ſecond term of the ſeries, or that which involves in it m^2. Now,

$$\frac{1+rg+\frac{r^2}{2}g^2+\&c.}{1+\frac{H+b}{2}g+\frac{H^2+Hb+b^2}{6}g^2+\&c.}=$$

$$1+\left(r-\frac{H+b}{2}\right)g+\left(\frac{r^2-r(H+b)}{2}+\frac{H^2+4Hb+b^2}{12}\right)g^2;$$

$$\text{and } g=log.\,(1-m)=-m+\frac{m^2}{2}-\&c.$$

$$\text{ſo that } g^2= \qquad m^2-\&c.$$

Therefore, by ſubſtitution, $$\frac{1+rg+\frac{r^2}{2}g^2}{1+\frac{H+b}{2}g+\frac{H^2+Hb+b^2}{6}g^2}=$$

$$1+\left(\frac{H+b}{2}-r\right)m+\left(\frac{r}{2}-\frac{H+b}{4}+\frac{r^2-r\,(H+b)}{2}+\frac{H^2+4Hb+b^2}{12}\right)m^2.$$

This gives z corrected for the temperature of the air, and the firſt inequality of expanſion. The ſecond term with coefficient m is De Luc's expreſſion, the third term with coefficient m^2 ariſes from the equable decreaſe of heat, and the above-mentioned inequality of expanſion.

To complete the effect of the ſecond inequality of expanſion, let $\frac{H+b}{2}-r=f$, and β be conſidered as variable. Then in formula, $\left(1-m\frac{m\beta^{\mu}}{b^{\mu}}\right)^{32-h}$ let m be the expanſion for 1° degree of heat, when the mercury is at the height γ, and retaining the other denominations as before, we have

$$y=\frac{-\int y\dot{x}}{p\left(1+\frac{fm}{\gamma^{\mu}}\beta^{\mu}\right)} \text{ and } py\left(1+\frac{fm}{\gamma^{\mu}}\beta^{\mu}\right)=-\int y\dot{x}\ \therefore$$

$p\dot{y}+$

$$p\dot{y}+\frac{pfm\beta^{\mu}\dot{y}}{\gamma^{\mu}}+\frac{pfm\mu y\beta^{\mu-1}\dot{\beta}}{\gamma^{\mu}}=-y\dot{x},$$ and, dividing by y,

$$\dot{x}=-\frac{p\dot{y}}{y}-\frac{fmp\beta^{\mu}\dot{y}}{\gamma^{\mu}y}-\frac{\mu fmp\beta^{\mu-1}\dot{\beta}}{\gamma^{\mu}}.$$

To exterminate from this equation y and $\dot{y}$, it is to be remarked, that $y=\dfrac{\beta}{p\left(1+\frac{fm}{\gamma^{\mu}}\beta^{\mu}\right)}$, and that therefore $\dfrac{\dot{y}}{y}=\dfrac{\dot{\beta}}{\beta}-\dfrac{\mu fm\beta^{\mu-1}\dot{\beta}}{\gamma^{\mu}+fm\beta^{\mu}}$. Hence by ſubſtitution, $\dot{x}=$

$$p\left(-\frac{\dot{\beta}}{\beta}+\frac{mfm\beta^{\mu-1}\dot{\beta}}{\gamma^{\mu}+fm\beta^{\mu}}-\frac{(1+\mu)fm\beta^{\mu-1}\dot{\beta}}{\gamma^{\mu}}+\frac{\mu^{2}f^{2}m^{2}\beta^{2\mu-1}\dot{\beta}}{\gamma^{\mu}(\gamma^{\mu}+fm\beta^{\mu})}\right).$$

$$\text{But } \frac{\mu^{2}f^{2}m^{2}\beta^{2\mu-1}\dot{\beta}}{\gamma^{\mu}(\gamma^{\mu}+fm\beta^{\mu})}=\frac{\mu fm\beta^{\mu-1}\dot{\beta}}{\gamma^{\mu}}-\frac{\mu fm\beta^{\mu-1}\dot{\beta}}{\gamma^{\mu}+fm\beta^{\mu}};$$

therefore $\dot{x}=p\left(-\dfrac{\dot{\beta}}{\beta}-\dfrac{fm\beta^{\mu-1}\dot{\beta}}{\gamma^{\mu}}\right)$, the other terms deſtroying one another. By integration, then, $x=p\left(-log.\,\beta-\dfrac{fm\beta^{\mu}}{\mu\gamma^{\mu}}+C\right)$. If C be taken ſuch that x may vaniſh when $\beta=b$, the height of the mercury in the lower barometer, we will have

$$x=p\left(log.\,\frac{b}{\beta}+\frac{fm(b^{\mu}-\beta^{\mu})}{\mu\gamma^{\mu}}\right).$$

That it may appear wherein this formula differs from the ordinary one, inſtead of b^{μ} and β^{μ}, we muſt introduce $log.\,b$, and $log.\,\beta$, which, when b and β are not very unequal, may be done without difficulty. For we have $\dfrac{b^{\mu}}{\gamma^{\mu}}=1+\mu\,log.\dfrac{b}{\gamma}+\dfrac{\mu^{2}}{2}\left(log.\dfrac{b}{\gamma}\right)^{2}+\dfrac{\mu^{3}}{6}\left(log.\dfrac{b}{\gamma}\right)^{3}+$ &c.; alſo $\dfrac{\beta^{\mu}}{\gamma^{\mu}}=1+\mu\,log.\dfrac{\beta}{\gamma}+\dfrac{\mu^{2}}{2}\left(log.\dfrac{\beta}{\gamma}\right)^{2}\dfrac{\mu^{3}}{6}\left(log.\dfrac{\beta}{\gamma}\right)^{3}+$ &c. Therefore $\dfrac{\beta^{\mu}-\beta^{\mu}}{\gamma^{\mu}}=\mu\left(log.\,\dfrac{b}{\gamma}-log.\,\dfrac{\beta}{\gamma}\right)+\dfrac{\mu^{2}}{2}\left(\left(log.\dfrac{b}{\gamma}\right)^{2}-\left(log.\dfrac{\beta}{\gamma}\right)^{2}\right)+$ &c. That is, $\dfrac{b^{\mu}-\beta^{\mu}}{\gamma^{\mu}}=\mu\,log.\,\dfrac{b}{\beta}+\dfrac{\mu^{2}}{2}\,log.\,\dfrac{b\beta}{\gamma^{2}}\times log.\,\dfrac{b}{\beta}$, rejecting all the terms which involve powers, of $log.\,\dfrac{b}{\gamma}$ of $log.\,\dfrac{\beta}{\gamma}$, and of μ, higher than the ſquare. Hence alſo, $\dfrac{fm(b^{\mu}-\beta^{\mu})}{\mu\gamma^{\mu}}=fm\,log.\,\dfrac{b}{\beta}+\dfrac{\mu fm}{2}\,log.\,\dfrac{b\beta}{\gamma^{2}}\times log.\,\dfrac{b}{\beta}$, and $x=p\left(log.\,\dfrac{b}{\beta}+\dfrac{fm\,(b^{\mu}-\beta^{\mu})}{\mu\gamma^{\mu}}\right)=p\left(log.\,\dfrac{b}{\beta}+fm\,log.\,\dfrac{b}{\beta}+\dfrac{\mu\,fm}{2}\,log.\,\dfrac{l\beta}{\gamma^{2}}\times log.\,\dfrac{b}{\beta}\right)$; or

$$\text{or } x = p\, log.\, \frac{b}{\beta}\left(1 + fm + \frac{\mu fm}{2}\, log.\, \frac{b\beta}{\gamma^2}\right).$$

The ſecond term f, m, p, log. $\frac{b}{\beta}$ is De Luc's correction, the third term is the correction for the inequality of expanſion of air by heat depending on its compreſſion. To aſcertain its exact amount, μ muſt be defined by farther experiments on the expanſibility of air, under different degrees of compreſſion. Let $\mu = \frac{1}{2}$, $b = 29$ inches, $\beta = 24$, $\gamma = 29{,}5$, then log. $\frac{b\,\beta}{\gamma^2} = -22$ nearly, multiplied into $\frac{\mu}{2} = -\frac{1}{16}$ nearly. Diminiſh, therefore, De Luc's correction $\frac{1}{16}$, before it is applied to the difference of the tabular logarithms, and the true height of one barometer above the other is given.

Let s = ſemidiameter of the earth, and the force of gravity vary as $\frac{1}{(s+x)^v}$, then compreſſing force at height x is denoted by $-\int \frac{s^v}{(s+x)^v}\, y\dot x$. Let q be the length of a column of mercury, compreſſing air, to the denſity of itſelf, $= 1$;

$$\text{then, } 1 : y :: q^{1+n} : \frac{\left(-\int \frac{s^v}{(s+x)_v}\, y\dot x\right)^{1+n}}{(1-m)^{\tau+\lambda x}}, \text{ and}$$

$$y = \frac{\left(-\int \frac{s^v}{(s+x)^v}\, y\dot x\right)^{1+n}}{q^{1+n}(1-m)^{\tau+\lambda x}}, \qquad \text{or } y^{\frac{1}{1+n}} = \frac{-\int \frac{s^v}{(s+x)^v}\, y\dot x}{q\,(1-m)^{\frac{\tau+\lambda x}{1+n}}},$$

In which formula, all the inequalities that have been enumerated are expreſſed, except that which was conſidered in the two preceding articles. Hence, multiplying by $q\,(r-m)^{\tau+\lambda x}$, and taking the fluxions, there comes out,

$$q\left(\frac{1}{1+n}\, y^{\frac{1}{1+n}-1}\, \dot y\,(1-m)^{\frac{\tau+\lambda x}{1+n}} + \frac{\lambda g}{1+n}\, y^{\frac{1}{1+n}}\,(1-m)^{\frac{\tau+\lambda x}{1+n}}\, \dot x\right) = -\frac{s^v y\dot x}{(s+x)^v}$$

Dividing therefore by y,

$$q\left(\frac{1}{1+n}\, y^{\frac{1}{1+n}-2}\, \dot y\,(1-m)^{\frac{\tau+\lambda x}{1+n}} + \frac{\lambda g}{1+n}\, y^{\frac{1}{1+n}-1}\,(1-m)^{\frac{\tau+\lambda x}{1+n}}\, \dot x\right) =$$

$-\frac{s^v\dot x}{(s+x)^v}$; and making $y^{\frac{1}{1+n}-1} = v$, and conſequently, $\frac{-n}{1+n}\, y^{\frac{1}{1+n}-2}\, \dot y = \dot v$,

$$\text{we have } \dot v\,(1-m)^{\frac{\tau+\lambda x}{1+n}} - \frac{n\lambda g}{1+n}\, v\,(1-m)^{\frac{\tau+\lambda x}{1+n}}\, \dot x = \frac{ns^v\dot x}{q\,(s+x)^v}.$$

This equation will become integrable if it be multiplied by $(1-m)^{-\lambda x}$, for it is then

$$\dot{v}\,(1-m)^{\frac{\tau-n\lambda x}{1+n}}-\frac{n\lambda g}{1+n}\,v\,(1-m)^{\frac{\tau-n\lambda x}{1+n}}\,\dot{x}=\frac{ns^{\nu}\dot{x}}{q\,(s+x)^{\nu}\,(1-m)^{\lambda x}};$$

and ſo $v\,(1-m)^{\frac{\tau-n\lambda x}{1+n}}+C=\frac{ns^{\nu}}{q}\int\frac{\dot{x}}{(s+x)^{\nu}\,(1-m)^{\lambda x}}$. But $v=y^{\frac{1}{1+n}-1}$ $=y^{-\frac{n}{1+n}}$, therefore, $y^{-\frac{n}{1+n}}(1-m)^{\frac{\tau-n\lambda x}{1+n}}+C=\frac{ns^{\nu}}{q}\int\frac{\dot{x}}{(s+x)^{\nu}\,(1-m)^{\lambda x}}$.

It is neceſſary to introduce β into this formula, by ſubſtituting for y, its value, $=\frac{\left(\frac{s^{\nu}}{(s+x)^{\nu}}\beta\right)^{1+n}}{q^{1+n}(1-m)^{\tau+\lambda x}}$; and, therefore, as $y^{\frac{n}{1+n}}=\frac{s^{n\nu}\beta^{n}}{q^{n}(s+x)^{n\nu}(1-m)^{\frac{n(\tau+\lambda x)}{1+n}}}$, we have

$$\frac{q^{n}(s+x)^{\nu n}(1-m)^{\frac{n(\tau+\lambda x)}{1+n}}}{s^{\nu n}\beta^{n}}\times(1-m)^{\frac{\tau-n\lambda x}{1+n}}+C=\frac{ns^{\nu}}{q}\int\frac{\dot{x}}{(s+x)^{\nu}\,(1-m)^{\lambda x}},$$

$$\text{or, }\frac{q^{n}(s+x)^{\nu n}(1-m)^{\tau}}{s^{\nu n}\beta^{n}}+C=\frac{ns^{\nu}}{q}\int\frac{\dot{x}}{(s+x)^{\nu}\,(1-m)^{\lambda x}}.$$

In the caſes which actually take place in nature, ν is either equal to $+2$, or to -1. It is equal to $+2$, when the barometer is raiſed above the ſurface of the earth, and to -1, when it is depreſſed below it. When $\nu=+2$, the laſt equation becomes

$$\frac{q^{n}(s+x)^{2n}(1-m)^{\tau}}{s^{2n}\beta^{n}}+C=\frac{ns^{2}}{q}\int\frac{\dot{x}}{(s+x)^{2}\,(1-m)^{\lambda x}}.$$

When x is ſuppoſed very ſmall in compariſon of s, the fluent $\int\frac{\dot{x}}{(s+x)^{2}\,(1-m)^{\lambda x}}$ may be expreſſed by a ſeries, converging with ſuch rapidity, that the two firſt terms will be ſufficient for the preſent purpoſe. Now, as $\frac{1}{(s+x)^{2}}=\frac{1}{s^{2}\left(1+\frac{x}{s}\right)^{2}}=$

$\frac{1}{s^{2}}\left(1-\frac{2x}{s}\right)$ nearly, $\frac{ns^{2}}{q}\int\frac{\dot{x}}{(s+x)^{2}\,(1-m)^{\lambda x}}$ becomes

$$=\frac{n}{q}\int\overline{(1-m)^{-\lambda x}\dot{x}\left(1-\frac{2x}{s}\right)}=\frac{n}{q\,(1-m)^{\lambda x}}\left(-\frac{1}{\lambda g}+\frac{2x}{\lambda gs}+\frac{2}{\lambda^{2}g^{2}s}\right).$$

Therefore, $\frac{q^n (s+x)^{2n} (1-m)^{\tau}}{s^{2n} \beta^n} + C = \frac{n}{q (1-m)^{\lambda x}} \left(- \frac{1}{\lambda g} + \frac{2x}{\lambda g s} + \frac{2}{\lambda^2 g^2 s} \right)$.

To define C, x muſt be put $= 0$, and $\beta = b$, ſo that

$\frac{q^n (1-m)^{\tau}}{b^n} + C = \frac{n}{q} \left(- \frac{1}{\lambda g} + \frac{2}{\lambda^2 g^2 s} \right)$, and $C = - \frac{q^n (1-m)^{\tau}}{b^n} + \frac{n}{q} \left(- \frac{1}{\lambda g} + \frac{2}{\lambda^2 g^2 s} \right)$.

If this value be ſubſtituted for C, and if all the terms be divided by $(1-m)^{\tau}$, we ſhall have

$$\frac{q^n (s+x)^{2n}}{s^{2n} \beta^n} - \frac{q^n}{b^n} = \frac{n}{q \lambda g} \left(\frac{1}{(1-m)^{\tau}} - \frac{1}{(1-m)^{\tau+\lambda x}} + \frac{2x}{s (1-m)^{\tau+\lambda x}} - \frac{2}{\lambda g s (1-m)^{\tau}} + \frac{2}{\lambda g s (1-m)^{\tau+\lambda x}} \right).$$

The approximation which has been uſed here for finding the fluent $\int \frac{\dot{x}}{(s+x)^2 (1-m)^{\lambda x}}$, is ſufficiently exact, becauſe no terms have been rejected but ſuch as are divided by s^2, and which, of conſequence, are extremely ſmall in reſpect of the reſt.

We are now to ſuppoſe, that x becomes equal to z, or to the whole height that is to be meaſured; then alſo, $\tau + \lambda x = r - h$, $\lambda = \frac{H-h}{z}$, and $\tau = r - H$; and ſo by ſubſtitution,

$$\frac{q^n (s+z)^{2n}}{s^{2n} \beta^n} - \frac{q^n}{b^n} = \frac{nz}{qg (H-b) (1-m)^{r-H}} \left(1 - \frac{1}{(1-m)^{H-h}} - \frac{2z}{gs(H-b)} + \frac{2z}{s(1-m)^{H-h}} + \frac{2z}{gs (H-b) (1-m)^{H-h}} \right) = \frac{nz}{qg (H-b)} \left((1-m)^{H-r} - (1-m)^{h-r} - \frac{2z}{gs (H-b)} (1-m)^{H-r} + \frac{2z}{s} (1-m)^{h-r} + \frac{2z}{gs (H-b)} (1-m)^{h-r} \right).$$

The value of z is to be found from this equation; and as the firſt ſtep in the approximation, we may ſuppoſe s ſo great in reſpect of z, that $s+z = s$, nearly; and, alſo, that all the terms divided by s vaniſh; which, in fact, is the ſame thing with ſuppoſing the force of gravity to be uniform. We have, then, $\frac{q^n}{\beta^n} - \frac{q^n}{b^n} = \frac{nz}{qg (H-b)} \left((1-m)^{H-r} - (1-m)^{h-r} \right)$, or, $z = \frac{\frac{1}{n} q^{1+n} g(H-b) \left(\frac{1}{\beta^n} - \frac{1}{b^n} \right)}{(1-m)^{H-r} - (1-m)^{h-r}}$.

To find the correction neceſſary on account of the diminution of gravity,

$$\frac{q^{1+n} \left(1 + \frac{z}{s} \right)^n}{\beta} - \frac{q^{1+n}}{b^n} = \frac{nz}{g (H-b)} \left((1-m)^{H-r} - (1-m)^{h-r} - \frac{2z}{gs(H-b)} (1-m) \right.$$

$(1-m)^{H-r}+\frac{2z}{s}(1-m)^{h-r}+\frac{2z}{gs(H-h)}(1-m)^{h-r}\Big)$ ſubſtitute the value of $z=q\left(1+m\left(\frac{H+h}{2}-r\right)\right)\left(\frac{q^n}{n\beta^n}-\frac{q^n}{nb^n}\right.$ where s enters as a diviſor, and we ſhall have a a more accurate value of z, and by neglecting the powers of m higher than the firſt, we have $z=p\left(1+m\left(\frac{H+h}{2}-r\right)\right)\,log.\,\frac{b}{\beta}+\frac{2p^2}{s}\left(1+m\left(\frac{H+h}{2}-r\right)\right)^2\,log.\,\frac{b}{\beta}+$

$$\frac{p^2}{s}\left(1+m\left(\frac{H+h}{2}-r\right)\right)^2\left(log.\,\frac{b}{\beta}\right)^2.$$

The firſt term is the height corrected by De Luc's method, the ſecond is the correction for diminution of weight of mercury in the higheſt barometer, the third for gradual diminution of weight of air between the higher and lower ſtations.

For depths below the ſurface of the earth, the compreſſing force at any depth $x=\left(\int\frac{s-x}{s}y\dot{x}\right)^{1+n}$, and proceeding as above, we have $z=p\left(1+m\left(\frac{H+h}{2}-r\right)\right)$ $log.\,\frac{\beta}{b}-\frac{p^2}{s}\left(1+m\left(\frac{H+h}{2}-r\right)\right)\,log.\,\frac{\beta}{b}+\frac{p^2}{2s}\left(1+m\left(\frac{H+h}{2}-r\right)\right)^2\left(log.\,\frac{\beta}{b}\right)^2.$

Hence to find at what depth the denſity of air becomes equal to that of mercury, which is ſuppoſed $=1$, p being equal to the column of mercury condenſing it, or to 4343 fathoms nearly, the denſity being as the compreſſing force and temperature equal to r. Then $z=p$, $\log.\,\frac{\beta}{b}+\frac{p^2}{2s}\left(\log.\,\frac{\beta}{b}\right)^2$ the term $-\frac{p^2}{2s}\log.\,\frac{\beta}{b}$ being omitted, as relating to the diminution of weight of mercury in the lower barometer, $b=\frac{5}{12}$, $\beta=4343$. $\therefore p\log.\,\frac{\beta}{b}=10000\times$ tab. log. $10423=40180$ fathoms $=45{,}6$ miles nearly. $\frac{p^2}{2s}\left(\log.\,\frac{\beta}{b}\right)^2={,}25$ of a mile, $\therefore z=45{,}85$ miles nearly. At the depth therefore of nearly 46 miles, the air will be of the ſame denſity with mercury, a paradox, which will be ſolved by conſidering, that the denſity of air is doubled by every deſcent of $3\frac{1}{2}$ miles.*

To find the limits of the atmoſphere, reſume the formula $y=\frac{\left(-\int\frac{s^{\nu}}{(s+x)^{\nu}}y\dot{x}\right)^{1+n}}{q^{1+n}(1-m)^{\tau+\lambda x}}$, and ſuppoſing the temperature $r+f$ uniformly diffuſed through it, we may ſubſtitute $1+fm$ for $(1-m)^{\tau+\lambda x}$. Let $a=q\,\overline{1+fm}^{\frac{1}{1+n}}$, and $s+x=v$ $\therefore ay^{\frac{1}{1+n}}=-\int s^{\nu}\,v^{-\nu}\,y\dot{v}$ $\therefore -\frac{a}{n}^{-\frac{n}{1+n}}+C=(\nu-1)\,s^{\nu}\,v^{1-\nu}$. Let $y=D$

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* Note. The denſity of the air at the ſurface $=0{,}00125$, that of mercury being $14{,}000$, the denſity of air at depth 46 feet is 8192, or 2^{13} times greater, $=8192\times{,}00125=10{,}2300$.

when $x = 0$, or $v = s$, and $C = \frac{a}{n} D^{-\frac{n}{1+n}} + (v-1)s$ ∴ if $v = 2$, $\frac{a}{n}\left(D^{-\frac{n}{1+n}}\right.$

$$\left. - y^{-\frac{n}{1+n}}\right) = s\left(\frac{s}{v} - 1\right).$$

Let n be negative, and the denſity as the power $1-n$ of the compreſſion, then $\frac{a}{n}\left(D^{\frac{n}{1-n}} - y^{-\frac{n}{1-n}}\right) = s\left(1 - \frac{s}{v}\right)$, and being made 0, the height of the atmoſphere $v = \dfrac{s^2}{s - \frac{a}{n} D^{\frac{n}{1-n}}}$.

It will be uſeful to bring into one view the different corrections that have been inveſtigated. The firſt approximation to the height without any correction is $z = p$, log. $\frac{b}{\beta}$.

1ſt. The firſt correction, that of De Luc's, $+ m\left(\frac{H+h}{2} - r\right) p$ log. $\frac{b}{\beta}$.

2d. For the decreaſe of heat and firſt inequality of expanſion, $+ m^2\left(\frac{r}{2} - \frac{H+h}{4} + \frac{r(r-H-h)}{2} + \frac{H^2 + 4Hh + h^2}{12}\right) p$ log. $\frac{b}{\beta}$.

3d. For the ſecond inequality of expanſion or variation, by a given charge of temperature, according to the preſſure, $+ \frac{\mu m}{2}\left(\frac{H+b}{2} - r\right) p$ *log.* $\frac{b}{\beta} \times$ *log.* $\frac{b\beta}{\gamma^2}$, or E being put for the firſt correction $+ \frac{\mu E}{2}$ *log.* $\frac{b\beta}{\gamma^2}$, or it may be more accurate to compute $p f m\left(\frac{b^\mu - \beta^\mu}{\mu\gamma^\mu}\right)$, which includes both the firſt and third corrections.

4th. For the departure of the law of the elaſticity of the air from the direct ratio of the denſity, $- \frac{n}{2} p\left(1 + m\left(\frac{H+h}{2} -\right)\right)$ log. $\frac{b}{\beta} \times$ log. $b\beta$.

5th. For the diminution of the weight of mercury in the upper barometer $+ \frac{2p^2}{s}\left(1 + m\left(\frac{H+h}{2} - r\right)\right)^2$ log. $\frac{b}{\beta}$.

6th. For the diminution of the gravity of the air in aſcending $+ \frac{p^2}{s}\left(1 + m\left(\frac{H+h}{2} - r\right)\right)^2 \left(\text{log. } \frac{b}{\beta}\right)^2$.

In theſe calculations, the barometers are ſuppoſed to ſtand in the ſame perpendicular, or ſo that a perfect equilibrium may take place in the air intercepted between them; otherwiſe a great degree of uncertainty will ariſe from the horizontal diſtance of the ſtations. Suppoſing two barometers raiſed above a third, one vertically, and the other removed into a colder climate, but to the ſame height, the former will appear more elevated than the latter from the greater cold, in which this laſt was placed.

The mean height of the barometer at the level of the ſea, and the mean temperature of the air in different regions, ſhould alſo be aſcertained, before the art of levelling extenſive tracts, by means of the barometer, can be brought to perfection. Under the line, the mercury at temperature 55° ſtands at 29,852 inches; in Britain, at 30,04 inches.

Another cauſe of error is the ſolution of moiſture in the air, which has a great effect in increaſing its elaſticity and expanſion for every additional degree of heat it receives, ſo that the expanſion increaſing from one degree of heat has been found by the manometer, to be at the boiling point nine times that of dry air. Hence at Spitzbergen, the rule for the meaſurement of heights was found to err greatly in exceſs, and the denſity of the air was greater, than could have been inferred from its compreſſion and temperature.

The barometer may be made the meaſure of the humidity of the air. Let $z = p\left(1 + m\left(\frac{H+h}{2} -\right)\right) \log. \frac{b}{\beta}$ be the true height between two ſtations, when the moiſture diſſolved in air is given, or $= 1$, if the moiſture is increaſed or diminiſhed, this expreſſion muſt be multiplied into $1 \pm \pi$ for the true height, $\pm \pi$ repreſenting the increaſe or decreaſe of the elaſticity of the air, ariſing from the diſſolved moiſture.

$$\therefore z = (1+\pi)\, p\left(1 + m\left(\frac{H+b}{2} - r\right)\right) \log. \frac{b}{\beta} \quad \therefore 1+\pi =$$

$$\frac{z}{p\left(1 + m\left(\frac{H+b}{2} - r\right)\right) \log. \frac{b}{\beta}}.$$ If error, $z - p\left(1 + m\left(\frac{H+b}{2} - r\right)\right) \log. \frac{b}{\beta} = e$,

$$\pi = \frac{e}{p\left(1 + m\left(\frac{H+b}{2} - r\right)\right) \log. \frac{b}{\beta}}, \text{ or } \pi = \frac{e}{z-e}.$$

The diſtance between the ſtations ought not to be ſo ſmall, that the unavoidable errors of obſervation may be conſiderable in reſpect of the whole, nor ſo great as to introduce error from other cauſes. It ought not to be leſs than 100, nor much greater than 500 feet.

Thus an hygrometer may be formed. The beginning or zero point of the ſcale may be fixed by aſſuming m or the expanſion of air for one degree of heat, $= ,00245$ when $\pi = 0$, or when the formula thus adjuſted gives the true height. This hygrometer, by meaſuring the humidity chemically united with the air, will be uſeful for aſtronomical purpoſes. For though the fractions π may not be directly as the differences of the humidity of the air, or the changes of refracting power, they are probably connected with theſe laſt by ſome fixed law, to be aſcertained by future experiments. And if the operation of humidity in changing the ſpecific gravity of air is altered by more powerful cauſes, the diſcovery of ſuch a fact will give a value to this new application of the barometer.